A. M. D. G.

BULLETIN

of the

American Association of Jesuit Scientists

(Eastern Section)

For Private Circulation

LOYOLA COLLEGE
BALTIMORE, MARYLAND

VOL. X — MAY, 1933 — NO. 4

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EASTERN STATES DIVISION

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EDITORIAL

"Ten Years"

Organization in any field of endeavor is helpful and useful, and in progressive endeavors is quite necessary. Education, and particularly educational systems, always have been problematical. The natural sciences form an essential part of our system of education, and necessarily so, because we are living in an age of phenomenal scientific progress. The American Association of Jesuit Scientists was organized in order to keep in touch with the progress of the scientific educational courses and programmes, to keep informed with the enormous amount of research problems that are in progress in our universities and to constantly improve our educational curriculum in the natural sciences. To accomplish this purpose, the first group of our science professors from the Maryland-New York Province and the New England Province, under the leadership of Father Michael J. Ahern, met at Canisius College, Buffalo, New York, in August 1922.

At this meeting a tentative constitution was suggested and a committee appointed to formulate the by-laws of the association. The following year, in August 1923, the first regular meeting of the newly formed organization was held at Fordham University; the constitution and by-laws were adopted, scientific problems were discussed, papers were read and Father Ahern was elected President of the association.

In 1924, the annual meeting was held at the new Jenkins Science Building at Loyola College, Baltimore, Maryland; and the following year the convention met at Holy Cross College, Worcester, Massachusetts, and Father G. Francis Strohaver was elected President. During this year the Science Schedule of Studies for the Bachelor of Science Degree was completely revised and organized. For two years Father Strohaver was in charge and at the next meeting Father Edward C. Phillips was the choice of the organization for President. Father Phillips, however, was unable to conduct the annual meeting of 1928, because in June of that year he went abroad to attend several international meetings of astronomers. In the absence of Father Phillips, Father Richard B. Schmitt was appointed President of the Science Association and he continued in this capacity for three years. The annual meeting of 1928 was held at Woodstock, Maryland. Since that time all the meetings were held at Holy Cross College, at the end of the Science Summer School. At the closing general session in August 1930, Father Clarence E. Shaffrey was elected President and he conducted the meetings for two years. For the present year (1932-1933) Father Joseph J. Sullivan of Boston College is in charge.

Since the beginning of the Science Association in 1922, about three hundred and thirty papers were read at these annual meetings and many profitable discussions were held. In 1929, a strenuous effort was made to have a coalition of the Science Association and the Philosophical Society, but no union was feasible.

One of the important functions of the American Association of Jesuit Scientists is the publication of the Bulletin. According to the constitution, article 10, number 1, this publication should contain articles on scientific topics and news of interest helpful to the members of the Association. The Editor-in-Chief is appointed by the Executive Council at the annual meeting. Accordingly, on August 11, 1923, at the annual meeting of the Executive Council, Father Henry M. Brock was elected Editor-in-Chief of the Jesuit Science Bulletin. Father Brock held this position for four successive years. In September 1928, Father Brock became ill and was unable to continue his splendid work; Father John L. Gipprich was chosen to succeed him.

The following year, in August 1929, Father Joseph P. Merrick was appointed Editor of the Bulletin. At the meeting held at Holy Cross College in August 1930, Father Richard B. Schmitt was elected Editor of the Science Bulletin and he has continued in this capacity for the past three years.

(Continued on Page 218)

RECORDING OF THE CAMAGUEY CYCLONE

Belen Observatory, Havana, Cuba

Rev. M. Gutierrez Lanza, S.J., Director

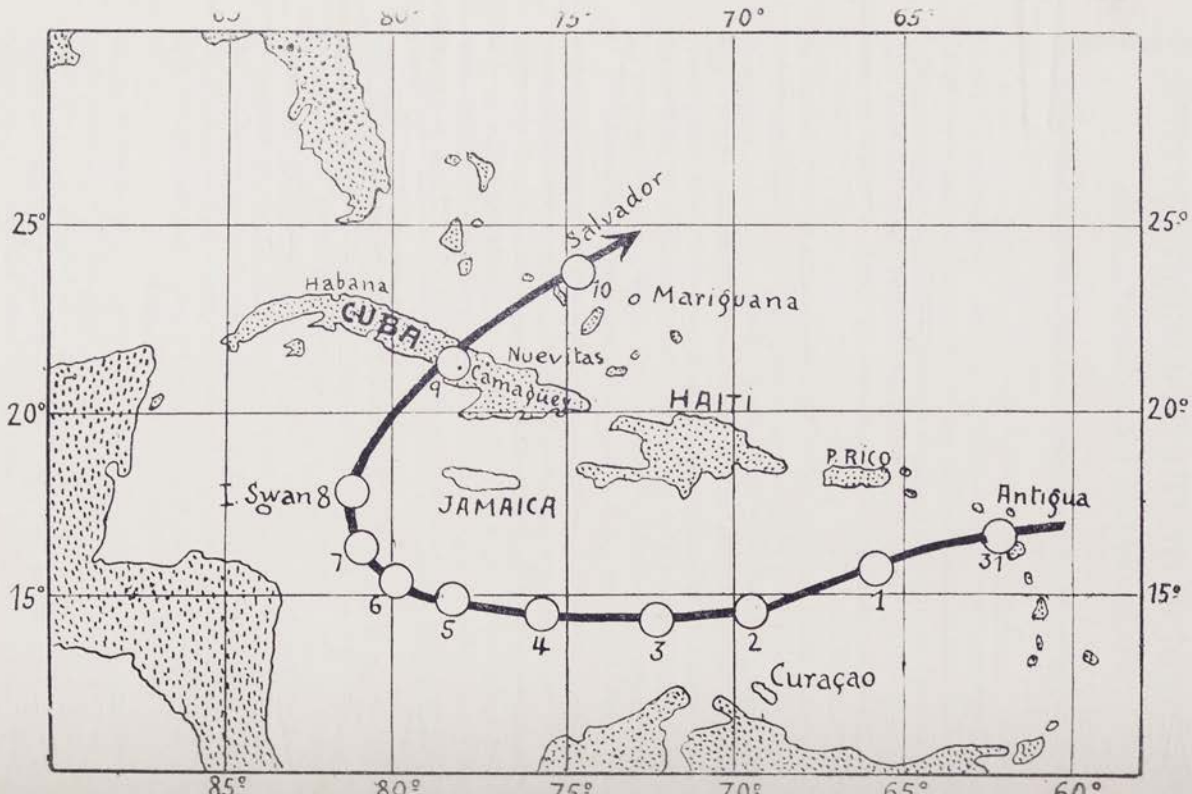
This cyclone was the most disastrous in the recollections of Camaguey. That province was considered to be almost immune from hurricanes, so much so that many sugar milling companies wholly neglected cyclone protection. In the past history of this province it has been very little affected by cyclones and then only by those of slight or very moderate intensity.

We know of no tropical cyclone in history which levied a tribute of human lives equal to the number of victims of the Camaguey hurricane sacrificed in the hecatomb of Santa Cruz del Sur. The exact number of the dead is not known, as very many were dragged into the sea and eaten by sharks. The estimated total is between 3,000 and 3,500, about one hundred of whom were from the rest of the province. It must be remembered that this locality is not usually visited by hurricanes and on that account it was not forewarned to take measures of precaution.

The area of destructive winds was extremely wide, at least when the storm swept out to sea. From Caibarien, where it demolished some buildings and caused a few deaths, to Guantanamo, where the wind reached the velocity of 74 miles per hour, and Baracoa, where it produced considerable damage, the distance is more than 250 miles on a line approximately perpendicular to the path of the cyclone as it left the island.

The maximum velocity of the wind was not determined with precision. The commandant of the gun-boat "Yara", in Nuevitas Bay, estimated it at 180 miles per hour, which we think is an over-estimate. Others calculated it at 90 miles only. This we consider too low. Still others fixed it at 120 miles per hour, equivalent to 53 meters per second which we judge to be about right. Judging by the pictures of the effects of the hurricane, published in the newspapers and magazines, we would say that in this hurricane the wind did not reach the force it had in the one that lashed Havana on October 20, 1926.

Our first visit to Santa Cruz del Sur was in 1910, when we went there to establish a meteorological station and install a mercury barometer, barograph, wind-vane, etc. As was jotted down in a note book which we have on hand, the cistern of the barometer was 130 cm. above sea level. This means that the floor of the house was scarcely one meter above sea level. All of the other houses were practically at this same level, with very few exceptions. The city consisted of a long row of



THE TRAJECTORY COURSE OF THE CYCLONE

houses at the mouth of the river facing the sea which was quite shallow and usually calm. The houses were set back from twelve to fifteen meters from the shore. The land behind this was at the same level as the city or even still lower for a distance of several kilometers, a situation which would put the people in extreme jeopardy in case a severe hurricane should flood the city with rolling waves, for then if the people had not escaped in front of the first waves, they would be hemmed in between the engulfing swells with all retreat cut off.

From time to time Santa Cruz del Sur experienced more or less alarming inundations of the sea. These occurred each time a cyclone passed by north or south of Cuba at no great distance. When the momentary danger had passed by, confidence in the supernatural always sprang up anew and the belief ever increased that Santa Cruz del Sur possessed a guardian angel with whose protection nothing serious was to be feared.

But November 9, 1932, a hurricane made a furious frontal attack on the sleeping city and in a few hours drowned the entire population in indescribable panic, distress and despair. The intensity of the cyclone was terrific and the path which the vortex followed was the most prophetic that could be imagined. The center of the whirlwind passed by a little to the left of Santa Cruz, and consequently the wind there was level, with very few exceptions. The city consisted of a long row of blowing from south to north and piling the waves up onto the city full force. Jucaro was on the left side of the hurricane and although it was just as near or nearer to the center than Santa Cruz, it was not so completely ruined because there the wind blew from north to south, that is, from the land towards the sea. At Jucaro the sea at first retarded, but later there was an inundation of the hurricane wave in the technical sense, that is, the accumulation of water which is caused by and accompanies the center of the vortex. Yet this did not have the same impetus as the waves at Santa Cruz which were raised and driven ahead by the hurrican winds. For this reason the damage done in Jucaro was nothing extraordinary whereas the catastrophe of Santa Cruz has no equal in cyclone annals, and that in spite of the fact that the wind was perhaps exceptionally strong in Jucaro as is seen from the comparative effects in all the parts of the island over which the cyclone passed.

Could this catastrophe have been avoided? We do not think so. If we take into account the psychology of the popular mind, it was humanly speaking inevitable. The only way in which it could have been avoided was to have persuaded the whole population to abandon the city en masse and move to a safer place; but no man, no matter what authority he might possess, would be able to persuade the whole city of Santa Cruz to abandon their homes and everything they possessed because of such a problematical danger as that of a cyclone, especially since there was no recollection of any previous tragedy which was caused by an inundation of the sea.

A communication which Mr. Eloy Garcia Figueroa addressed to the Honorable Secretary of the Government, was published in "El Mundo", and in it we read about "a notice of Fr. Gutierrez Lanza saying that there was no danger for Camaguey and so it could be reassured." We wish to correct his information. During the whole of this cyclone, and even during the whole of the past cyclone season we have not sent one solitary telegram to Santa Cruz nor to any other point in the province of Camaguey. As a matter of fact we have not had any communication with most of our observers on the greater part of the island, the exceptions being those stations which are connected with Havana by cable lines, Cienfuegos, Manzanillo and Santiago de Cuba. The following ca-

IN THE CITY OF CAMAGUEY

ble was sent to Manzanillo and Santiago de Cuba at 2 P. M. on the 8th: "Cyclone recurving west of and near to Jamaica. Be on guard." Several inquiries came from Cienfuegos. The replies pointed out the probability of the danger until the morning of the 8th when we announced that the danger had passed. As for the rest of the stations, where there is no cable, such as Nuevitas, Puerto Padre and Gibara to the north, Santa Cruz del Sur, Jucaro, and Tunas de Zaza to the south, there was practically no communication with them during the whole of the past cyclone season and not one telegram passed between them and the observatory.

It should be well understood then that during the whole of this cyclone we did not send any word of warning or otherwise either to Santa

Cruz del Sur or to any other place in Camaguey. Moreover our unvarying statements in regard to the proximity of danger for Cuba were the following: (1) There is no danger for the western province. (2) The situation is threatening for the eastern provinces. (3) The middle provinces may be affected.

With respect to the absence of danger in the western provinces, this we vouched for firmly and tenaciously to the end. All the island and especially Havana was well aware of this. We were in suspense and sometimes alarmed in regard to the jeopardy of the middle provinces. On the 7th we were extremely alarmed for these provinces but on the morning of the 8th we judged that serious danger was already past. The eastern

AEROPLANE VIEW OF THE CITY BEFORE THE CATASTROPHE

provinces we thought were most seriously threatened.

A brief synopsis of our bulletins to the public will bear our point.

November 4. "Considering the lateness of the season, we do not think there is any danger for Cuba, at least for the western half."

November 5. "The cyclone is south of Jamaica and quite intense."

Such information as we had received was very slight.

November 6. "The storm has developed into a severe tropical hurricane. It is about to recurve. Tomorrow will decide the direction of its return track and whether it will affect Cuba and what part of it. We continue to be optimistic for the western part of the island."

November 7. (9 A. M.) "Our opinion is that it will take a course more to the east (of Havana), perhaps through the central provinces and perhaps even farther east. We do not think that the western provinces or Havana will be affected."

November 7. (9 P. M.) "It is still recurving and consequently still further eliminating Havana from the danger zone. It is either decreasing in intensity or moving away from Swan Island—a favorable sign for Havana and an indication of less danger for the rest of the island."

Destruction in the City

November 8 (9 A. M.) "We can definitely dismiss all fear of danger for the western provinces. Central provinces almost certainly out of danger and less likelihood of danger for the eastern provinces. The cyclone is situated south-southwestward of Jamaica and on completing its recurve, will travel northeastward or east-northeastward. If the latter is true, Jamaica and probably the southeastern part of Cuba will be in its path, but in case of the former, the central provinces are in danger. The intensity of the cyclone is still very great."

November 8 (9 P. M.) "The recurring cyclone has turned northeastward and is lashing the extreme western part of Jamaica. Tonight and tomorrow it will probably be felt more or less severely in the province of Santiago de Cuba and perhaps moderately also in the province of Camaguey. We hope that it will yet incline more towards the east-northeast, over the Jamaica mountain range and will have lost much of its force before it approaches the extreme east of Cuba."

November 9. (9 A. M.) "Since this morning the cyclone is touching on the eastern provinces of Camaguey and Oriente. The center will enter near Santa Cruz del Sur and go northeastward or perhaps incline to the east-northeast. It will cross over the whole island today. It will be very severe in Ciego de Avila and even as far as Zaza the winds will be moderately dangerous. In Santiago de Cuba the winds will not be able to vent their full force because of the mountain range. Santa Clara will suffer some but not disastrous effects from the cyclone."

This is a faithful synopsis of the cyclone forecasts contained in the Belen Observatory bulletins which were published in the press and sent to the radio stations. From them it is evident, first, that we stated explicitly that the western provinces and in particular Havana were free from danger. This was reiterated time and again without ambiguity, from start to finish. In the second place, they express, sometimes implicitly, and sometimes explicitly, that the danger was threatening for the eastern provinces. Finally, they state the situation to be doubtful in the central provinces and still dangerous until the morning of the 8th when it was said that almost all danger had disappeared.

At no time did we say that Camaguey or Oriente were out of danger. So far were we from revoking our warning of danger for the eastern provinces, that in our last bulletin on the night of the 8th, we added the following paragraph: "The forecast of the course of the cyclone as contained in our first communication to the press is being substantially verified. There we said that it would recurve northeastward or east-northeastward in low latitudes and that it would threaten our eastern but not our western provinces." This was the backbone of our program during the whole course of the cyclone, and to state it as being verified on the very eve of the cyclone was a confirmation of the forecasts of danger contained in it. What do the facts say? They say that the cyclone actually swept over the eastern provinces, passed up Pinar del Rio, Havana, and Mantanaza, and was from slightly to moderately destructive in the district of Santa Clara bordering on Camaguey.

Still there are some who think that Belén Observatory was mistaken, for, although the predictions that there was no danger for Havana and the western provinces was verified and although practically all communications with our observers were broken, still the gravity of the danger in Camaguey was not stated explicitly and concretely enough; the place where the storm would enter was not predicted; and the forecasts did say that the storm would probably recurve more to the east-northeast and consequently reduce the proximity of danger.

The cyclone clouds were visible at the observatory already on the afternoon of November 7. On that afternoon there were a few brief moments of panic in Havana when the sky took on a threatening aspect with low racing clouds and strong gusts of wind. Fortunately the squall lasted only a few minutes and then the sky cleared up and peace of mind was restored. In the evening a veil of fan shaped cirro-stratus formed with radii converging towards the horizon south-southwest of Havana, showing clearly the direction in which the center of the cyclone was situated.

Very early on November 8, the cyclone arc of cirrus clouds began to project out over our horizon but at a very low altitude. This arc still remained south-southwest of us. During the whole day it was slowly rising at an angle which increased towards the left accordingly as the storm ascended to a higher latitude and completed its recurve. This was a clear indication all day long of the inclination of the storm towards the east, but the exact degree of the inclination could not be determined. One thing however was certain, namely, that it would not strike the western half of the island. Moreover the tendency of the wind at Cienfuegos to back towards the north showed us that this city also was out of serious danger. Then we transmitted to the Observatory of Montserrat, to the "Correspondencia" and to various commercial and maritime offices a message announcing that Cienfuegos was out of danger.

Although the situation seemed to be very threatening for the eastern provinces on the 8th, we received some observations from Jamaica which apparently showed that we could hope for the better. In the early morning the wind at Punta Negril was from the southeast with a velocity of 40 miles per hour, and with the barometer at 751 mm. Early in the afternoon Kingston announced that it had not yet been able to make connections with Punta Negril. Hence it was clear that the cyclone was quite intense over the western part of Jamaica, and that was a hint that the storm would probably recurve more sharply to the east-northeast and consequently there was a chance of our eastern provinces escaping the full force of the storm. In the forecasts of the 8th, we mentioned this chance and hoped that it would be so, but without revoking the warnings of danger either for Camaguey or for Oriente. As a matter of fact there was considerable damage done by the cyclone in the extreme west of Jamaica, but it was due to the great width of the storm, which did not recurve east-northeastward but northeastward on a track heading for Camaguey. After it had crossed Cuba it inclined more to the east-northeast as the accompanying chart shows.

It has become necessary for us to revise our description of the course of the hurricane as it was published in the Havana press on November 20. This is because we have lately received more precise data from important places in the devastated region, which compel us to make some modifications in our description of the storm track, its direction and velocity, the width of the area under the vortex and other important points.

In order to trace out more definitely the road followed by the center of the vortex, we are going to give in detail the data we have received from different places on both sides of its path, with a warning, however, that it is impossible to delay over all of the information in a satisfactory manner. There is some conflicting data about the time of the calm at the various stations. This may be due partly to differences in the time of the clocks used, but for the most part we attribute these differences to changes in the inclination of the eye of the storm due to its oscillating motion, sometimes moving zig-zag across its mean track, sometimes drawing out the area of calm into an eliptical form with changes in the orientation of its axis, and sometimes forming a cycloidal shape with to and fro movements accompanying the lateral deviations. Moreover, the calm area seems to have increased greatly after entering on the south coast of the Island and until it passed over the north coast into the Atlantic. This can be seen from the data which is appended for the perusal of the interested reader.

Information Received

Jucaro.—Mr. Jose M. Maldonado, Master of the Yacht "Azias", sent us a barogram, and the following shift of the winds: NE., N., NNW., NW. There was no calm. He adds that he learned from friends who were miraculously saved in Santa Cruz, that there was no calm there, and that the wind there veered from E. to SE., S. and SW. Another friend of his on board a barge in a tributary of the Santa Maria, told him that he was in a calm from 35 to 40 minutes.

C. "Agramonte".—Mr. George G. Harris favored us with a barometric curve showing a minimum of 715 mm. The vortical calm lasted from noon to 1:45 P. M. The wind came first from the E. and SE. and after the calm from the NW. and W. He adds that the C. "Vertientes" had the same winds, and a calm period approximately from 11:30 A. M. to 1:00 P. M.

Camaguey.—Press data and a personal letter have fixed the calm period at from 12:00 M. to 3:00 P. M., and the barometric minimum at 710 mm.

C. "Florida".—The Honorable Administrator honored us with a barometrical record in which the pen went off the sheet and so the minimum could not be ascertained. Another little barometer went down to 721 mm. The calm lasted from 12:00 M. to 2:00 P. M.

Florida.—Mr. Jesús Abreu was kind enough to inform us that the calm lasted from 12:00 M. to 2:30 P. M. and that the wind came, first from the ENE., and after the calm from the WNW.

Minas.—Mr. Pedro de Armas, Correspondent of the "Camagueyano", has kindly sent us some detailed information: Wind E.; from 1:00 to 3:00 P. M. calm; repairing his roof; from 3:00 to 3:20 P. M. light breeze from W.; at 3:30 P. M. the wind increased to destructive force; 70 houses blown down, among them the Catholic and Protestant Churches and the

Electric Plant; at 4:40 P. M. ten minutes of calm followed by a strong south wind for 25 minutes; another calm of five minutes, after which a raging west wind until 5:50 P. M. This decreased rapidly and by 6:00 P. M. both wind and rain had stopped.

C. "Senado".—Mr. Apolinar L. Alsaga, the Administrator, was kind enough to send the barometric readings: the minimum being 706 mm. at 4:40 P. M. The calm lasted from 3:00 to 4:40 P. M. The wind shifted from ESE. and E. before the calm to W. afterwards with terrific intensity.

C. "Jaronu".—Mr. Sergio Perez favored us with the information that during the calm, from 2:30 to 3:30 P. M., the sky cleared and leaves were still. It was preceded by ENE. winds and followed by NW. winds with much greater force and twisters.

Nuevitas.—Mr. Jose Soler kindly informed us that the calm began at 4:30 P. M. and the sky was clearing until about 5:00 P. M. The winds were from ESE. and S. before, and stronger from WNW. after the calm.

Nuevitas.—The "Yara". We were furnished with abundant information by the Commandant of our gunboat, "Yara". The barometric minimum was 705 mm. The calm lasted from 4:30 to 5:15 P. M. The wind veered from ESE. to WNW.

S. S. "Aldecoa".—Lat. 25°, 53', N. Long. 71°, W. Mr. Francisco Aldecoa, Captain, honored us with the barometric record and stated that there was a relative calm at 1:30 A. M. on November 11. The wind shifted from ENE. to NNE. and NW., in violent squalls.

In all of the above-mentioned places the calm was observed. These places are in some instances very far from the cyclone track. For instance at C. "Jaronu", the calm lasted an hour and on the "Yara", anchored at Ballenato del Medio, in the Nuevitas bay, it lasted 45 minutes; which shows that the width of the calm area extended still quite some distance beyond these points away from the center. Even as far as the C. "Cunagua" to the west, the relative calm was observed according to Dr. Adolfo Saret; and to the east as far as Puerto Padre, according to Dr. Francisco R. del Pueyo, the Director of the College Marti. We also received a barometric graph from C. "Manati" and detailed observations from Caibarien, through the courtesy of Dr. Jose Arcos Garcia. We wish here to extend to all these contributors our profound gratitude.

An analysis of the preceeding information shows that the vortex entered between Macurijes and Santa Maria, and that it passed west of but close to Camaguey. The duration of the calm was: at Santa Maria, 40 minutes; at C. "Vertientes", 1 hour 30 minutes; at Camguey, 3 hours; at C. "Agramonte", 1 hour 45 minutes; at C. "Florida", 2 hours. At Minas the calm was repeatedly interrupted by winds from various directions and of varying intensity. At C. "Senado", the calm lasted 1 hour 30 minutes, and finally at C. "Jaronu", and in the Nuevitas Bay, 1 hour and 45 minutes respectively. The immediate conclusion drawn from this is that the area of the calm increased rapidly and very noticeably on its course across the Island.

The calm began at Vertientes at 11:30 A. M.; at Camaguey, C. "Agramonte", and C. "Florida", at 12:00 M.; at Minas at 1:00 P. M.; at C. "Jaronu", at 2:30 P. M.; at C. "Senado", at 3:00 P. M., and at Nuevitas at 4:30 P. M. C. "Vertientes" and Nuevitas are 60 miles apart, and the distance was covered in 5 hours, which places the velocity of the storm's forward motion at 12 miles per hour. Moreover the center of the cyclone entered on the southern coast at approximately 10:30 A. M., and the barometric minimum on the "Yara", when the cyclone passed into the Atlantic, was at 4:45 P. M., thus giving 6 hours, 15 minutes for the time of crossing, which corresponds with the preceding figures. This seems to prove that the velocity was not under 12 miles per hour.

What was the total diameter of the vortex? That is a difficult point to settle with precision, as there are clear indications that its size was changing all the time. If we supposed that this calm space was of unchanging and circular shape, and that it traveled in a straight line without oscillating from side to side, it would be necessary to fix the diameter at about 70 miles in length when it left the Island, but relatively small, perhaps only 20 miles in length, when it entered the Island. The assumption of 36 miles which we made, represents the calm area at 1:00 P. M. At that hour the border of the calm area was just entering Minas, while the Centrals "Agramonte" and "Florida" were in the center of the cyclone, and C. "Vertientes" was at its rear border. Drawing a circle with the center a little west of Camaguey, and letting it pass through Minas, it will leave "Senado" just outside, and places the Centrals "Florida" and "Agramonte" well inside, and also includes C. "Vertientes". There we have the approximate area of the vortex at the hour mentioned, and the diameter is about 36 miles in length. This result also gives us at 12 miles per hour as its velocity, since the calm lasted 3 hours at Camaguey. The heavy line representing the path of the center of the vortex is to be taken as the mean course which it followed and not as its actual course, for very probably it underwent a variety of abnormal and complicated movements due to the great inclination of the axis of the vortex.

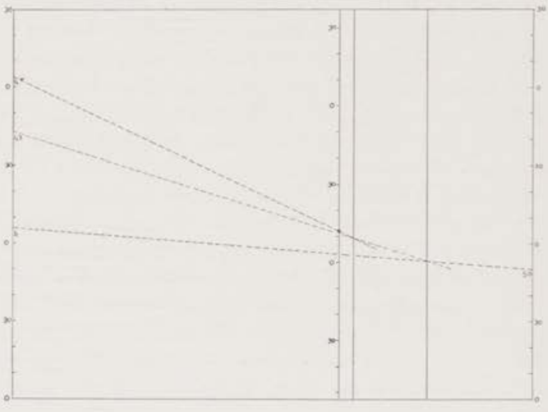
Let us conclude these lines by recalling this sorrowful lesson, that cyclones that come late in the year are likely to be seriously threatening for our eastern provinces.

ASTRONOMY

A GRAPHIC INTERPOLATION OF THE TABLES FOR MOONSET

Rev. John A. Blatchford, S.J.

Although the numerical computation of moonset is not a difficult problem it requires nevertheless several interpolations usually involving rather cumbersome fractions. The graphic method here described was devised by Rev. Frederick W. Sohon, S. J. It is far more rapid than the numerical one and involves a minimum of mental effort. By its aid the determination of moonset can be made accurately to the nearest minute of time in the short space of a few seconds.



The diagram shown in the illustration was made for the Residence of St. George's College, Kingston, Jamaica, where the latitude is 17° 58′ 26″.6 N. and the longitude is $5^h\ 7^m\ 8^s.16$ W. It will serve the double purpose of showing the graphic method of interpolating the tables and the manner of constructing the diagram for a given place. The graph consists of five verticle scales, parallel to each other, and numbered from one to five beginning with the right hand scale. The proper spacing and division will be explained later.

To use the diagram four entries must be made. The values used are taken from the table of Moonset in the American Ephemeris and are entered on the diagram with the assistance of a straight edge and stylus (or pin) in the following order:

1) On Scale 1, (the right hand scale) place the point of the stylus on the time of moonset for latitude 20°, same day as wanted.

2) Place one end of the straight edge against the stylus point and rotate the other end to the time of moonset on Scale 5 for latitude 10°, same day.

3) Holding the straight edge in this position move the stylus to the intersection of Scale 2 with the straight edge and rotate the other end to the time of moonset on Scale 5 for latitude 20°, on the following day.

4) Holding the straight edge in this new position place the stylus on its intersection with Scale 3 and rotate the other end to the time of moonset on Scale 5 for latitude 10°, on the day following.

5) The answer will be found on Scale 4 at its intersection with the straight edge. A small circle has been drawn on the diagram to indicate this spot in the example given.

The dotted lines show the successive positions of the straight edge for a model determination of moonset at Kingston for November 26, 1932. The data needed from the Ephemeris are as follows:

Date	10°	20°
Nov. 26	$16^h\ 6^m$	$15^h\ 50^m$
Nov. 27	$17^h\ 4^m$	$16^h\ 43^m$

The time will be found to be 16^h and 12^m or 4:12 P. M. Eastern Standard Time.

The diagram after a little preliminary computing can be constructed in a short time. First determine the spacing of the vertical scales.

Let N_1 be the time at latitude 20° for the same day.
" N_2 " " " " " 10° " " " "
" N_3 " " " " " 20° " " following day.
" N_4 " " " " " 10° " " " "
" M_1 " " " " " 17° 58′ 26″.6 for the same day.
" M_2 " " " " " " " " following day.

All the above values are for the meridian of Greenwich.

Interpolating, now, between 10° and 20° for 7° 58′ 26″.6 or 7°.9741.

$$M_1 = N_2 + \frac{7.9741}{10}(N_1 - N_2)$$

$$M_1 = 0.7974N_1 + 0.2026N_2 \qquad (1)$$

$$M_2 = N_4 + \frac{7.9741}{10}(N_3 - N_4)$$

$$M_2 = 0.7974N_3 + 0.2026N_4 \qquad (2)$$

Interpolating between two successive days or 24 hours for the difference in longitude, $5^h\ 7^m\ 8^s.16$ or $5^h.1189$ to get Local Civil Time:

$$\text{L. C. T.} = M_1 + \frac{5.1189}{24}(M_2 - M_1)$$

$$\text{L. C. T.} = 0.7867M_1 + 0.2133M_2$$

$$\text{L. C. T.} = 0.6273N_1 + 0.1594N_2 + 0.1701N_3 + 0.0432N_4 \qquad (3)$$

The coefficients of N in equation (3) give the relative value to assign each scale.

If we let the distance (a_1) of Scale 1 from Scale 5 be some convenient unit such as 10 inches then the distance of the various scales from Scale 5 may be found in the following manner:

$$a_1 = \frac{10 \text{ x } 0.6273}{0.6273} = 10 \text{ inches for Scale 1.}$$

$$a_2 = \frac{10 \text{ x } 0.6273}{0.6273 + 0.1594} = 7.9741 \text{ inches for Scale 2.}$$

$$a_3 = \frac{10 \text{ x } 0.6273}{0.6273 + 0.1594 + 0.1701} = 6.5567 \text{ inches for Scale 3.}$$

$$a_4 = \frac{10 \text{ x } 0.6273}{0.6273 + 0.1594 + 0.1701 + 0.0432} = 6.2733 \text{ in. for Scale 4.}$$

The diagram may be constructed most readily on graph paper which is ruled in multiples of 10. Having drawn the scales in position, divide Scale 1, 4 and 5 into 150 equal parts, representing 150 minutes or two and one-half hours in all. Scale 4 should begin with 7.1 minutes so as to read in Eastern Standard Time otherwise it will give Local Civil Time.

If the station had been 7.1 minutes east of the standard meridan instead of west of it the zero of Scale 4 would have been shifted upwards 7.1 minutes so that the scale would have begun with 52.9 minutes of the previous hour.

This diagram could be used for a place with the same numerical coordinates but East of Greenwich by making the entries in the following order:

1)	Enter	the	time	of	moonset	for	20°	same	day	on	Scale	1.
2)	"	"	"	"	"	"	10°	"	"	"	"	5.
3)	"	"	"	"	"	"	20°	preceding	day		"	5.
4)	"	"	"	"	"	"	10°	"		"	"	5.

Scale 4 will begin with 52.9 minutes as mentioned above.

It is also evident that the diagram can be used for determining the times of moonrise, sunrise and sunset from their respective tables in the Ephemeris.

For those who may be interested in the intermediate steps performed on each scale the following explanation of the model example is appended:

$$\text{Scale 2 gives } 16^h\, 6^m - \frac{7.9741}{10}\,(16^h\, 6^m - 15^h\, 50^m) = 15^h\, 53^m$$

$$\text{Scale 3 gives } 16^h\, 43^m - \frac{6.5567}{7.9741}\,(16^h\, 43^m - 15^h\, 53^m) = 16^h\, 2^m$$

$$\text{Scale 3 gives } 17^h\, 4^m - \frac{6.2733}{6.5567}\,(17^h\, 4^m - 16^h\, 2^m) + 7^m.1 = 16^h\, 12^m$$

For further explanations and the proof of the theory, which depends on the properties of similar triangles, the reader is referred to standard works on the subject of Nomography.

STATUS OF THE WEATHER MAN

Leo G. Welch, S.J.

A weather-man must be a humble chap. He must be willing to be catalogued in the family of scientists as a little below the ground-hog. The number of people who believe in the objective value of weather proverbs, perhaps far exceeds the number that has much faith in the weather-man. It was interesting to notice in the N. Y. Times for February 2, that the official meteorologist, in his pronouncements on the popular Candlemas weather proverb, was somewhat loath to uproot belief in its value. A leading official of the Boy Scout Organization who was interviewed on the same subject, showed no such tactful hesitancy. The meteorologist, perhaps, appreciates the value of the tradition as such. It is scientifically harmless and at least furnishes many people with a topic of conversation. Popular weather lore is as old as man and has contributed many interesting anecdotes to the world's literature. On this account meteorologists have good reason to mitigate their exposure of its scientific worthlessness.

The weather-man's humility is tried more seriously when a U. S. Senator gets up in Congress, as one recently did, and advocates abolishing the Weather Bureau on the ground that it has given us "neither more nor better weather". Perhaps the senator recalled that, in 1891, Congress appropriated $9,000 for experiments in rainmaking and bemoans the fact that the present-day Weather Bureau budget is not used for such practical purposes. The senator's words reflect to some degree the opinions of thousands of our scientifically enlightened Americans. The days of swindling with rainmaking prospectuses are not over. Fake forecasters' predictions of severe storms a year ahead of time are given as much if not more credence than the Weather Bureau's forecast of tomorrow's rainfall. As in other scientific departments, here, too, the quack is conspicuous for his success in the popular imagination. Somehow or other the successful predictions of fake forecasters are long remembered and his failures immediately forgotten, whereas it is just the opposite in the case of the scientific forecaster. If we can argue from the premise that the memory retains unusual incidents much better than ordinary occurrances, this fact is a great tribute to the success of our official weathermen.

The men who issue fake forecasts usually make their predictions so indefinite as to time and place that, with the infinite variety of weather which at one time prevails over a large country like the United States, it is practically impossible for them not to hit upon a success in some locality. Hence their claim to success. Those who wish to bolster up their position usually proffer periodicities discovered in climatic history or weather cycles due to the movements and positions of the moon, planets and stars, as the scientific basis of their predictions.

The moon has long been a **refugium peccatorum meteorologicorum.** Aristotle discussed the weather in the light of lunar changes. The Greek poet Aratus wrote,

> "But chiefly look to Cynthia's varying face;
> There surest signs of coming weather trace."

Even nowadays it is not hard to find people who say that when the horns of the moon point up, the bowl holds water and rain is scarce; but when one horn is lower, the bowl being tipped spills water and there is plenty of rain. The lunar and planetary theories of weather have been repudiated time and again by scientific investigations.

Climatic periodicities have been discovered by the dozens. Scientific examination has shown that so far such cycles are either indefinite or, if expressed precisely, they usually break down when tested over long periods. One of the most famous, Bruckner's cycle of 34.8 years for its average length, was constructed out of individual cycles which ranged from 20 to 50 years in length, with only one cycle out of five coming within 2½ years of the expected length. In order to fit data into cycles the original figures have usually been changed substantially by extensive smoothing. Then the so-called cycles require enormous arithmetic magnification in order to be seen by the human eye. Add to these changes those which result from the superposition of some twenty-five cycles, ranging in wave length from 6 to 7 days to 99 years, and the results are obviously too complicated to be used for forecasting.

Mr. C. J. P. Cave, a noted meteorologist of England, at one time checked up on forecasts published in the "Daily Mail" based on 7-day cycles. One supporter described them as "a billion times better than fortuitous predictions and a notable advance in meteorological science". After Mr. Cave had compared them with the observed weather, he wrote, "The forecast, even for one week ahead, have not any success. They are not any better than could be obtained by purely fortuitous predictions, and they agree with what one would expect from chance in a very marked way." (1) Forecasts based on cycles have frequently been published in the press in this country and have at times been compared with the Weather Bureau records. As far back as 1904, Mr. Garriott, after one such investigation, wrote, "The forecasts of warm and cold waves, if reversed, would result in a higher percentage of verification." (2)

At the present time the only cycle that has not been discarded as useless for forecasting is the sun-spot cycle of eleven years. In the figurative language of Napier Shaw the sun is the furnace which supplies the energy that runs the atmospheric engine and solar radiation is the agency by which the energy is conveyed to the earth. At times of sun-spot maximum solar radiation is greater than at spot minimum. Differences in the amount of energy supplied to the atmosphere ought to find their counterpart in the work done by the atmospheric engine. However the only resulting phenomenon which we can trace directly to the sun-spot cycle is the coincident change of temperature in the tropics, being higher during spot minimum and lower during spot maximum. The amplitude of this change amounts to only a fraction of a degree. Solar influences will find their way from equatorial to temperate latitudes, but by so many devious ways, unconnected in time or place, that it is impossible to trace them back to their origin in solar changes. Work is being done towards this end, but so far it has not produced any appreciable results.

Although, contrary to the opinions of most people, forecasting is not the only work of the meteorologist, reliable long-range forecasting is one of the goals he most assiduously aims at. At present forecasts for periods longer than a few days in advance are out of the question. When press notices announce that the coming season is going to be mild or severe, rest assured that the author of the notice has as a reason for his information, not scientific data, but a desire for notoriety. Serious meteorologists would welcome the discovery of any cycle which is definite and derived from scientific examination of accurate evidence, but such a cycle has not yet been discovered.

But is the senator's seathing oratory any reason for the scientific forecaster to skulk away in disgrace? The annual appropriations for the Weather Bureau are now about $4,500,000.00. Compare that amount with the value of the property saved due to some of the storm warnings sent out. Maritime interests perhaps benefit most by the weather reports. "Warnings displayed for a single hurricane are known to have detained in port on our Atlantic coast vessels valued with their cargoes at over $30,000,000." (3) Radio warnings are especially advantageous to ships, not only for the purpose of keeping them out of the storm centers, but also because they enable captains to proceed on their way with safety much sooner or by a shorter route than they would dare do without continual assurance from the Weather Bureau office. Oftentimes delayed entry into port would mean an immense loss for the owners of the vessel.

Fruit growers in the Western states depend to a great extent on the Weather Bureau warnings for smudging or heating their orchards, especially during the blossoming period. "In the citrus-fruit districts of California it is reported that fruit to the value of $24,000,000 was saved by taking advantage of warnings issued by the Bureau during one cold wave." (4) At another time agricultural products to the value of $100,000 were saved on one night in a limited district of Florida, due to warnings of freezing weather. The property protected and saved because of the forecasts of another cold wave was estimated at $3,500,000.

Railway and transportation companies make use of forecasts for protecting perishable products against temperature changes. On reception of cold-wave warnings, preparations are made in city heating plants for increased demands. The Forest Service depends on the Weather Bureau for warnings of fire weather, and ease up on fire-fighting operations when rain is predicted. The value of spraying and dusting orchards and vegetables depends to a great extent on subsequent weather conditions. Cold-wave and rain forecasts are used by contractors in their concrete and roofing work. "In advance of a predicted storm, rice planters flood their crops to prevent the straw from being broken by the wind." (5) Aeroplane companies are now one of the biggest beneficiaries of the Weather Service. Many companies require their pilots to be well versed in theoretical and practical meteorology. On some lines the pilots are informed every ten minutes on the conditions of cloud, visibility and wind which they must expect along the next stage of their route. The climatological data compiled by the Weather Bureau are used for determining sites of dams, bridges, reservoirs, irrigation systems, sanatariums, homes and summer resorts. Many more uses made of the forecasts are described in letters continually flowing into the Weather Bureau offices. In spite of the general popular opinion on the verification of the forecasts, those industries which are continually making use of the forecasts, claim to obtain good results thereby. A careful comparison of the forecasts with the weather observed has shown a verification of between eighty-five and ninety per cent.

The attempt at rainmaking on the part of the Government, in 1891, was a fiasco. Meteorological science has not advanced any further in that direction nor are meteorologists interested in that phase of the problem. They have told us that it would take a 36,000,000 horse-power engine a whole week to do as much work as is done by nature in producing an inch of rainfall over an area of ten square miles. They have furthermore pointed out the reasons why it is impossible to make or stop a shower by any mechanical contrivances which we now possess. Revolutionary changes will have to take place in mechanical invention before we can even dream of controlling the weather.

The field in which meteorological science has made its most rapid advance in the present century is the exploration of the upper atmosphere. Teisserene de Bore, in June 1899, was the first to direct the attention of meteorologists to the stratosphere as a region where temperature changes varied little with height. The relations between pressure and temperature in the upper air have been investigated, especially by the late W. H. Dines, of London. The direction and velocity of upper-air currents, the changes of water-vapor content with height, temperature inversions at high elevations, the indentification of air masses according to origin and tracing the life history of such masses are the subjects about which our knowledge has greatly increased due to the investigations of the upper atmosphere. Records of the changes going on at great heights have been obtained by kites and sounding balloons which carry automatic-recording instruments, by pilot balloons which are followed with a theodolite, by aeroplane flights, and by less numerous balloon ascents, the most famous of which, of course, were the two record-breaking ascents of Prof. Picard. At the beginning of 1931 there were about 57 Weather Bureau pilot-balloon stations in the United

States, where from two to four balloon observations were made daily. The Navy Department has been making regular observations by aeroplane for some years. Last year the Weather Bureau made arrangements with air-transport companies for daily flights at six stations throughout the country.

One of the most important changes in meteorological theory which has taken place in the present century, is the modification of views held on the nature of the construction of extra-tropical cyclones. Instead of visualizing a cyclone as a symmetrical distribution of the attending phenomena about a single point of reference, as was done in the old theory, the new conception divides the area of the cyclone up into two unequal portions whose dividing lines meet at the center. The smaller sector is on the southern side and consists of a projection of warm air into a region of cold air which occupies all of the remaining area of the cyclone. The eastern boundary line between the two kinds of air is called the warm front. At this boundary the warm air mounts up and over the cold air. The expansion and cooling of the warm air gives rise to a prolonged rainfall of the gentle and dreary type. At the western boundary line between the two sectors, the cold air underruns the mass of warm air. This boundary is called the cold front and is marked by a sudden drop of temperature, rising of the barometer, a change of wind direction and increase in its velocity. This section is also called the squall line as it is usually attended by squally and rough weather.

This theory of cyclonic structure forms but a phase of the modern conception of the circulation of the atmosphere as a whole, which is known as the polar-front theory. The cause of atmospheric circulation is the differences of temperature between polar and equatorial regions. The polar-front theory claims that the smoothing out of these differences of temperature is brought about by a system of alternate polar currents winding down and tropical currents winding up spirally round the earth's axis. The boundary surface which marks the temporary southern limit of the polar-air masses is called the polar-front surface. This front lies in the temperate zone and is usually a wavy line in continual motion due to the projections of large masses of polar and tropical air in opposite directions. On the east side of cold-air projections the two currents are deflected from each other, and the resulting air deficit gives rise to a cyclone or cyclone family. On the western border of a polar projection, the earth's rotation will press the polar and tropical currents together so as to form an accumulation of air above the region of their mutual boundary line. This process is postulated as an explanation of the formation of moving Highs.

Beginning with the development of the polar front hypothesis, meteorological theory has become divorced from the statistical means and the vertical vortices of the previous century. Cyclones and anticyclones are no longer regarded as independent entities of revolving fluid, forming distinct units with homogeneous vertical structure. In the modern view they are visualized as advective or divective regions of the general circulation, and convection is regarded, not as an isolated operation, but as an integral part of the general system of air transportation. Any air mass in motion will continue moving along a river-bed route whose restraining banks are called isentropic surfaces. These surfaces are the paths along which a mass of air may move without any gain or loss of heat as a whole, that is, only adiabatic changes take place within them. Since adiabatic changes can take place very rapidly and an intercommunication of heat between two air masses is a very slow process, air motion along isentropic surfaces is much more unusual than across them. The exploration of the upper air has shown that isentropic surfaces may be inclined to the horizontal at any angle and may bend upwards as well as down. Hence the normal air flow does not follow the horizontal plane so much as was formerly supposed, and convection is not always due to insolation.

In the earlier development of the polar front theory, attention was centered mostly on the troposphere. Of late years however, with the increase of information relating to the stratosphere, it is more and more apparent that cyclones and anticyclones have their counterpart, if not their cause, in the overlying stratosphere. An especially close relation seems to exist between the pressure at the 9 km. level and surface phenomena. Going still higher, recent discoveries seem to show a marked coincidence between the pressure at 9 km. and the variable ozone layer between 40 and 50 km., the amount of ozone being greatest over cyclones and lowest over anticyclones. In anticyclones the area of highest pressure at 9 km. is situated somewhat to the southwest of the highest pressure at the surface and incidentally the least amount of ozone is found to be directly over this area. The variations in the amount of ozone are known to be due to the dissociation of 0_2 by ultra-violet radiation. Varying solar radiation, therefore, must play an important part in changing the thickness of the ozone layer. Measurements of solar radiation, of the ozone layer and of the meteorological phenoemna at 9 km. may establish a chain by which we can connect surface weather to sunspots and other solar phenomena. We can look forward hopefully to the results of further investigations along this line.

Hand in hand with these theoretical groupings, meteorologists have been searching for an empirical key to long-range forecasting by investigating the correlations between the elements of the weather in different parts of the world at different times of the year. Practically the only success attained in this direction so far, is the establishment of correlation coefficients of India's rainfall, which have made it possible to predict seasonal rainfall in India with fair accuracy.

Renewed hope of success in this direction has been created by the introduction of a new method of attack. The old method sought for the solution in mountainous accumulations of mean values, which values, of course, never expressed the actual conditions at any one time. The new plan is to start off with the individual observations made at one and the same hour over the whole world or a large part of it, and stury the subsequent course of events. For this purpose the weather bureaus of some countries have begun to make daily weather maps of the whole of the Northern Hemisphere. The best of these maps, since it contains the maximum possible amount of detail, is the chart whihc the **Deutsche Seewarte** of Hamburg has recently undertaken to produce on behalf of the International Meteorological Organization. Meteorologists hope that the study of these charts will make it possible to understand the causes of long spells of abnormal weather. As the number of observing stations in the Southern Hemisphere is quite small, it is not yet possible to make daily maps for the whole world, but that would be the ideal. Some meteorologists have recently focused our attention on the billions of tons of air which find their way across the equator and are inviting discussion on the correlative effects this phenomenon must produce.

Meteorology is discovering more new problems than it solves. But there are hopes that future meteorologists may enjoy the results of the indefatigable labors of the present generation which is traveling over such a circuitous route of complex and complicated postulates. Future weather-men will not be able to give us "more and better weather", but perhaps they may be able to give us more precise and detailed information about the coming weather for a longer time in advance.

References:

(1) C. J. P. Cave, **Nature**, CIX, p. 52.

(2) E. B. Garriott, **Long-Range Weather Forcasting**, (Washington: Gov't Printing Office, 1904), Bulletin No. 35—W. B. No. 35, p. 8.

(3) E. B. Calvert, **The Weather Bureau** (Washington: Gov't Printing Office, 1931), U. S. Dept. of Agriculture, Miscellaneous Publication No. 114, p. 17.

(4) **op. cit.** p. 18.

(5) **op. cit.** p. 24.

BIOLOGY

SPERM SLIDES

Lloyd F. Smith, S.J.

Those who have tried to prepare sperm slides according to the approved methods of technique books must have had unusual ability, or rare good fortune (or were easily satisfied) if they met with anything but disappointment. A couple of years a professor of this department happened to make a slide or two which were quite satisfactory, but, unfortunately, forgot the method of making them. For almost a year, off and on, we had tried to duplicate his results, experimenting with many stains on five or six hundred slides with indifferent success, before we found the following method, which turned out to be something of an improvement on his work.

Choice of Sperm

The sperm of all animals is not uniformly accessible to most laboratories. But in some of the common animals, chiefly the Carnivora, due to their breeding habits, sperm is difficult to procure even with the animal on the dissecting board. Thus the sperm of the dog and cat seem to remain in the epididymis or in the testis until just before or during copulation; and a smear of the testis or epididymis of these animals leaves on the slides, in addition to the few sperm, many spermatocytes, spermatogonia, spermatids, immature sperm, blood cells, glandular secretions and other obscuring, non-essential details. In Rodents (Rat, Guinea Pig, Rabbit, etc.) the sperm is always present in enormous quantities in the vas deferens and hence easily obtained. Of these the guinea pig sperm is by far the largest, especially in the prominence of the head. It is about 100 microns long and can be studied by a class to advantage even under high power, although oil immersion is preferable From examination of slides secured from various supply houses we find that for class use it is superior in practically every respect to the sperm of the Ascaris, Earthworm, Grasshopper, Lobster, Necturis, Chicken, Rat, Rabbit, Cat, Monkey, and Man. Accordingly because of its ease in procuring, its large size and its typical structure, we decided to work with the sperm of the guinea pig.

Obtaining the Sperm

A recently killed, sexually mature, male guinea pig, preferably one that has been breeding in the past few days, is opened along the mid-ventral line. The testis will be found in the abdomen. Free the vas deferens from surrounding tissues along its whole course, cut it off at either end and wash away any blood. Hold the vas at one end with a pair of forceps and with another pair, or with the fingers, press the contents out the other end. A good sized drop should be obtained from each vas. Wipe off the drop on the bottom of a small dish, such as a Syracuse wash glass. Dilute with warm (body temperature) normal saline solution, about 50 to 100 drops of water to the drop of sperm. Mix water and sperm gradually, making smears on slides and examining them under the scope until the desired dilution is obtained. The heads of the guinea pig sperm are biconcave disks, like red blood corpuscles, and often show the same tendency to clump together in the rouleaux typical of erythrocytes. On the slide this gives the optical illusion of a multiflagellate sperm. If this occurs they may be readily separated by sucking them up repeatedly into an eye dropper and forcibly squirting them out again.

Fixation

Select a large glass container with a tight fitting top. Cover the bottom with 40% formaldehyde. Place the diluted sperm in its dish within the container so that the sperm does not come into contact with the formaldehyde, but is exposed to its vapors. Cover the container tightly. Allow the sperm to be exposed to the fumes for an hour or two.

Making the Smear

One good method of making the smears is to take some tissue paper, fold it so that it is the desired width of the smear (e. g. ¾ of an inch), dip it into the mixture and draw it once across the middle of each slide. Allow the sperm to dry on the slide, but not too long. Apparently it is best to let the smear dry just enough to become firmly attached to the slide, which will be when all moisture visible to the naked eye has evaporated. Over an hour of drying seems definitely injurious.

Staining

We have tried most of the usual stains, Heidenhain's, Cyanin and Erythrosin, etc., but had no luck with them. Ehrlich's triple was finally chosen. The formula was taken from Guyer's Animal Micrology, p. 223, No. 42.

Orange G, Sat. aq. sol.	14 c. c.
Acid fuchsin, sat. aq. sol.	7 c. c.
Distilled water	15 c. c.
Absolute alcohol	25 c. c.
Methyl green, sat. aq. sol.	12 c. c.
Glycerin	10 c. c.

Each solution is thoroughly saturated for a few days. The ingredients are then added in the order named, shaking the mixture well before each addition. Guyer recommends that the mixed stain be allowed to stand several weeks before using, but we employed it in a day or two. As for the absolute alcohol there is no apparent reason for not substituting the same amount of 95% alcohol.

But the real secret in using the stain seems to be its dilution. Dilute the stain with distilled water. The exact amount of water to be added cannot be decided in advance, though about equal proportions of stain and water will probably be found correct. The only sure test is to put a few drops of stain in the middle of a piece of filter paper and let it spread. When the stain has stopped spreading the filter paper should show 3 distinct colors in concentric circles. The inner should be a deep blue-green, surrounded by a narrow area of orange and an outer circle of bright red.

Stain for 1 hour to indefinitely, examining from time to time. Take the slide out of the stain, wash in water, blot with filter paper, cover. If too long in water (for more than 10 minutes) a considerable portion of the stain will be washed out.

The only good picture we have seen of the guinea pig sperm is on p. 15 of "Traite D'Embryologie Des Vertebres", by A. Brachet, published by Masson et Cie. Paris. Wilson in his "Cell in Development and Heredity" on p. 294 gives a picture of the head of the same, but it does not appear as typical as Brachet's.

The figure below is a camera lucida drawing from one of our slides set up under oil. The swelling on the connecting piece was taken from another slide (Turtox).

Guinea Pig Sperm (About 1000 x)

1. Acrosome or perforatorium. 2. Nucleus. 3. Neck. 4. Connecting piece. 5. Main piece of tail. 6. End piece or terminal filament.

Indentifiable on Sperm Slides

On slides made in the above manner the following parts may be seen. The sperm is composed of 3 parts, head, middle piece and tail, each of which has 2 parts (following Wilson's terminology).

In full face view the head is pear-shaped, slightly flattened at its narrower end. The basal portion is the nucleus, which is about half covered by the large acrosome, which might give the impression of a large transparent chef's cap on a bald head. The limits of the acrosome are seen about half way down the nucleus as a distinct transverse line.

The middle piece, attached to the narrower part of the head, is definitely eccentric in position. It includes the neck and connecting piece.

The neck is extremely short, about 3 or 4 microns long, cylindrical in shape. If great care is taken as regards light, aperture, cleanliness of optical parts etc. the proximal centriole can be seen in the neck, next to the nucleus, without too severe a strain on the imagination. The connecting piece can be seen to be about the length of the entire head, cylindrical, slightly smaller than the neck in diameter, and often showing some trace of the spiral filament in it. About at the mid-point of the connecting piece a definite swelling can be seen in some spermatozoa; the fact that it is wanting in others may be due to its having been dissociated during preparation.

The tail is composed of a main piece and an end piece. The main piece of the tail is its chief element, tapering very gradually to its almost pointed end. It is by far the longest part of the whole sperm, at least 70 microns long. Coming off the very tip of the main piece is the very fine, tiny terminal filament, about 4 or 5 microns long. In some instances a delicate accessory filament may be thought to be seen along either side of the middle piece and most of the tail. But it is not reported in text books generally and with our slides its presence could not be demonstrated.

Until recently no supply house of the many we tried offered guinea pig sperm slides for sale. We sent one of our slides to Turtox (General Biological Supply House, Chicago). They were kind enough to pay the compliment of attempted duplication. When satisfied with their experimenting they sent a slide asking for criticism. In general their slides, now on sale, show a better general contrast between nucleus and acrosome than do ours, the neck is more prominent, and the swelling in the connecting piece more constant and beautifully stained. Ours probably show the exact limits of the acrosome better, mark out the connecting piece more clearly and at least give a hint of its spiral filament. Also the smear itself is definitely better, the spacing being more even and the relative number of good sperm per unit area greater. Possibly a combination of the two methods would give a better slide. We have sent them our method and requested theirs in order to experiment further. Any interested in sperm slides may obtain, of course, a sample from Turtox or the loan of a slide from the writer.

NOTE—In our actual preparation of slides, instead of diluting the sperm with normal salt solution, we accidentally used the McJunkin-Haden bucer solution. Cf. McClung, "Microscopical Technique", p. 246. Its formula is—

Monobasic potassium phosphate	6.63 gm.
Anhydrous dibasic sodium phosphat	2.56 gm.
Distilled water	1 liter.

The actual effects, if any, on the results have not been checked up yet. But it is practically sure that normal salt solution will prove equally efficient.

CHEMISTRY

DETERMINATION OF BEESWAX IN CANDLES

Edward S. Hauber, S.J.

In ascertaining the constants of beeswax and of candle mixtures, the determination of the saponification number seems to be the one about which the authors disagree most as regards detailed procedures, and the analyst who reads the considerable volume of literature on this general subject (1, 3, 6, 7, 8, 10, 12, 14) is inclined to agree with Werder (16) when he complains about the many different methods that have been suggested for this particular determination. Winkler (17), however, is about the only one who presents detailed experimental proof for his particular procedures. Having been called upon some years ago to conduct a good many "candle analyses", we were struck with this abundance of methods and paucity of experimental evidence, and after considerable preliminary experimentation we fixed upon a certain detailed procedure which we are satisfied gives accurate results.

Determination of Saponification Number

In Table I is summarized the method recommended as giving quantitative saponification in the shortest time, using potassium hydroxide in absolute ethyl alcohol, which the authors consider the easiest, cheapest, and most accurate alkali to work with.

The saponification together with the subsequent titration is carried out in 500-cc. Pyrex Kjeldahl flasks. Refluxing is provided for by fitting them with test-tube condensers connected in series to the water supply (5). The flasks are boiled on an asbestos gauze over a Bunsen flame at such a speed that the solvent drops back into the boiling mixture at the rate of about 2 drops per second. The sides of the flasks are protected against overheating by placing over the gauze a square of asbestos in which a hole about 4.5 cm. in diameter has been cut, thus allowing only the bottom of the flask to get the direct heat of the gauze. After boiling, the indicator is added and the mixture titrated boiling hot with carefully standardized hydrochloric acid of the same strength as the alkali used.

Table I. Summary of Method

Substance	Strength of Alkali	Vol. of Alkali	Wt. of Sample	Time of Boiling	Phenol-Phthalein Used Indicator
	N	*cc*		*Hours*	*cc*
Candle mixtures	0.5	40-50	3.5 ± 0.4 gr.	2.5	1
Pure beeswax	1	40-50	3.5 ± 0.4 gr.	2	1

Table II. Results of Time Series

Saponifying Soln.	Time of Boiling Hours	No. of Individual Detns. Made	Av. Saponification No.
	Pure Beeswax		
1 *N* KOH	0.5	4	96.2
1 *N* KOH	1	4	96.4
1 *N* KOH	2	4	98.2
1 *N* KOH	3	4	98.3
0.5 *N* KOH	1	2	93.9
0.5 *N* KOH	2	6	97.9
0.5 *N* KOH	3	6	98.0
	Common Candle Mixture (a)		
1 *N* KOH	0.5	4	111.0
1 *N* KOH	1	4	112.5
	Second Known Candle Mixture (b)		
1 *N* KOH	0.5	2	44.0
1 *N* KOH	1	2	44.0
1 *N* KOH	2	5	45.4
1 *N* KOH	3	3	46.0
0.5 *N* KOH	3	3	46.3

(a) Beeswax, 51 per cent; stearic acid, 30 per cent; paraffin, 19 per cent; calcd. saponification no., 112.2.

(b) Beeswax, 15 per cent; stearic acid, 15 per cent; paraffin, 70 per cent; calcd. saponification no., 45.8.

The following precautions must be observed: The burets must be accurately calibrated, and the one containing the alcoholic solution should be allowed to drain 10 minutes before reading. The alkali after filtering must be kept in a tightly stoppered brown bottle and its potassium hydroxide equivalent checked frequently by running at least two blanks in exactly the same way as the saponification itself is conducted. The wax sample should be introduced in the form of a little ball, weighed to the nearest milligram, and a few small glass beads added to insure quiet boiling. The determination must be run in duplicate and, in case these do not agree within about a milligram, another pair should be run.

Once a certain sample weight and a certain kind and quantity of alkali solution have been decided upon, completeness of saponification can be proved only by running a time series. These series were run with one N and with 0.5 N solutions of potassium hydroxide in absolute ethyl alcohol on the same sample of beeswax, and then on two common candle mixtures of known composition and constants. The results are summarized in Table II.

Complete times series were not run on other saponification media, but one N potassium hydroxide in absolute methanol and on N sodium ethylate gave satisfactory results in 2 hours, as might be expected, and the results of Kettle (11), who uses one N potassium hydroxide in isopropyl alcohol to saponify beeswax in 10 minutes were also confirmed. However, unless time is the primary consideration, this method is not recommended, as the isopropyl alcohol, besides being more expensive to buy, cannot be recovered profitably from the saponification mixtures as can ethyl alcohol, about 75 per cent of which can be recovered by the use of a 2-foot Vigreaux column.

Determination of Acid Number

The conditions for accuracy for this determination are the use of a fairly large sample, on account of the small numerical value of this constant for most candle mixtures, and the use of an alkali which does not induce appreciable saponification. As these conditions are easily met, most of the methods given in the literature will be found suitable. A good method is titrating a 10-gram sample dissolved in 250 cc. of 95 per cent ethyl alcohol with 0.5 N aqueous potassium hydroxide solution, using 10 drops of one per cent phenolphthalein as indicator, and finishing at a noticeable pink color which persists on half a minute's boiling. A blank is run on the alcohol. This treatment causes no appreciable hydrolysis of the esters present unless the mixture contains about 35 per cent or more Japan wax. Pure Japan wax is so easily hydrolyzed that its acid number had to be determined by dissolving 2.5 grams of it in 250 cc. of carbon tetrachloride and titrating the warm solution with 0.1 N sodium ethylate; the end point lasted about a minute.

Interpretation of Results

The practice of using beeswax candles in the liturgy of the Catholic Church can be traced far back into Christian antiquity, but the actual decree of the Sacred Congregation of Rites which gives rise to this particular analytical problem dates from 1904 (2). The passage of interest to the chemist may be translated as follows: " . .. . the Paschal candle, the candle used in blessing the baptismal water, and the two candles lit on the altar during Mass are to be of beeswax, at least in largest part (maxima pars); the other candles on the altar should be either in greater part or of a noticeable proportion of the same wax." This "maxima pars" is usually taken to mean 51 per cent. The following compositions are common in American candles sold for church use:

	%	%	%	%	%
Beeswax	100	60	51	13	15
Stearic acid	...	20	30	37	15
Paraffin	...	20	19	50	70

In examining candles made by any reputable American manufacturer, it may be assumed that they contain only these three substances; and as the only esters in a ternary mixture of this kind are present in the beeswax, analyses usually calculate the percentage of this substance by using the principle given by Hehner (9), although not in exactly the same form as he published it. Since the stearic acid, if any, affects both the acid number and the saponification number equally, the percentage of beeswax may be calculated from the expression:

$$\%\ \text{beeswax} = \frac{\text{ester number of candle}}{\text{ester number of beeswax}}$$

For example, in the case of the 51 per cent candle used in one of the time series (Table II) and whose acid number was found to be 75.1, we have

$$\%\ \text{beeswax} = \frac{112.5 - 75.1}{73.1} = 51.2\%$$

from this the amount of stearic acid is calculated to be 30.0 per cent, and that of the paraffin (by difference) to be 18.8 per cent. Comparison with the actual composition of this mixture (which was unknown to the analyst) shows very satisfactory agreement, and about of the order to be expected when the procedure is conducted carefully and the constants of the candle ingredients are known. As a rule, however, these are not known, hence no analysis of this kind should be "guaranteed" closer than 5 per cent. As regards the value for the ester number of beeswax, a minimum value evidently works to the favor of the manufacturer, yet to be fair to the purchaser as well, it is customary to use the value of 72 for this constant (when it is not known), this being its lowest value given by the U. S. P.

In case the candle seems to be composed of other substances than the three mentioned, the chemist will find the problem (which may become very complicated, treated quite adequately in the literature cited, to which may be added the general method given by Elser (4) based on the melting points of the products obtained by the fractional crystallization of the candle mixture from benzene, and also the method of Watson (15) for estimating carnauba wax. A glycerol test (qualitative at least) should always be run on a large sample of all candle mixtures to see if any Japan wax is present, from which "synthetic beeswax" may be made (13) which can simulate exactly the ester number of true beeswax. It has been our experience, however that candles notably below par in beeswax content are made so by the addition to the beeswax of unduly large amounts of stearic acid and paraffin, rather than by the substitution of any other ingredients for the beeswax itself. In fact, so far we have not met with any indications of dishonest practice in cases where the beeswax content was stamped on the candle.

Acknowledgment

The authors wish to acknowledge with thanks the materials and the information supplied by Norbert J. Baumer of A. Gross and Co., Baltimore, Md., and the valuable suggestions of H. E. Cutts, of Stillwell and Gladding, New York, N. Y.

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STOCK ROOM SUGGESTIONS

Rev. Joseph J. Sullivan, S.J.

Because of the prevalence of dust and various vapors which tend to deposit upon all exposed surfaces in the Chemistry Laboratory and also in the Chemistry Stockroom, we found it advantageous to wrap all our glassware and porcelainware in paper.

This, of course, immediately met with the objection that when a piece of apparatus was covered it was impossible to distinguish sizes which were not greatly different from one another as in the case of a 150 or 200 cc Erlenmeyer Flask. To obviate this difficulty, we chose a series of colors which represented different sized articles.

Our color scheme was somewhat as follows: Pink for the largest size, green for next largest size, gray for next largest size, and then the scheme was repeated. This repetition of color scheme obviously would not cause any difficulties because the difference in size between two pink-wrapped items would be so great that the experienced stockroom man would not mistake a 1000 cc beaker for a 500 cc beaker, supposing that two intermediate sizes were 600 and 800 cc.

This color scheme was held to consistently for all glassware and porcelainware in our stock room. Geakers, Kjeldhal Flasks, Graduates, Flat and Round Bottom Boiling Flasks, Funnels, Hirsch Filters, Evaporating Dishes, all were wrapped according to this color scheme so that when the Stockroom Man thought of a certain size he thought of a definite color.

The paper we used was of a cheap grade and the quantity used for each item was so small that the cost of wrapping was hardly noticed as compared with the cost of washing and drying these various items which were constantly taking up dust and various deposits from the air.

Probably every stockroom must on occasions become a washroom. That certainly was the case at Boston College where every morning found an accumulation of glassware of various sorts and sizes all of which was dirty in most instances with a superficial deposit whose source was the air, which is the ordinary air of the Chemistry Laboratory.

The time of wrapping these items probably may alarm one, if one figures that it has to be done all at once, but we went at our proposition very slowly and now when a student comes to our stockroom window for a 250 cc Erlenmeyer Flask or a Liebig condensor, he is given a piece of glassware which we can guarantee is clean, whole, and entire.

This eliminates congestion at the stockroom window and complaints that apparatus was received in objectionable condition, all of which helps to good order and cleanliness in the laboratory.

As regards the lockers themselves, when a man is checked out of a locker and completed it with all items which are supposed to be there,

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MATHEMATICS

METHOD FOR POINTING OFF RESULTS IN SLIDE-RULE CALCULATIONS

BERNARD A. FIEKERS, S.J.

Though many methods are in vogue for determining the decimal point in slide rule calculations, the writer has found the following very helpful. He has applied it to the solution of compound fractions on the "C" and "D" scales ,and found that it coordinates his use of the slide rule with the ordinary system for determining the characteristics of logarithms. For "ours" then, who are constantly using both logarithms and slide rule in the courses of elementary physics, quantitative analysis, etc., this method might have some appeal.

It supposes that the user of the slide rule employs the extremities on the "C" scale as INDICES in any operation on the "C" and "D" scales. If some are in the habit of using the "D" scale extremities as indices, some slight changes in the following procedure will have to be made.

The first step is to find the characteristic of each member of the fraction, just as you ordinarily would if you were solving by logarithms. Subtract the algebraic sum of the characteristics of the denominator from those of the numerator.

Secondly, correct this total from the following data: During any PARTICULAR OPERATION, note how often the LEFT index on the "C" scale lies to the LEFT of the CORRESPONDING index on the "D" scale. For every time this occurs ADD one to the total number of characteristics, when your operation is in MULTIPLICATION; when it is in DIVISION, SUBTRACT one. From the resulting number of characteristics, point off your results just as you would when using logarithms.

In as much as the Briggsonian logarithm is an exponent of ten, multiplication and division resolve themselves respectively into the addition and subtraction of these exponents. The slide rule applies this principle in part, by adding or subtracting only that part of the logarithm known as the "mantissa". The person using it must take care of the characteristic for himself. But it sometimes happens that in adding or subtracting mantissas, a digit is carried over and added to or subtracted from the characteristic. A little inspection of the slide rule will show that when this occurs, it is indicated in an operation on the "C" and "D" scale

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PHYSICS

THE STROBOSCOPE AND SOME OF ITS APPLICATIONS

Rev. Henry M. Brock, S.J.

An ordinary student might perhaps be rather sceptical if told that it is quite possible to read with ease a newspaper clipping attached to a disk or shaft spinning some 1800 R. P. M. A physicist however knows that this can be done with the aid of some type of stroboscope. The latter strictly speaking is not a special instrument, and this may be the reason why ordinary textbooks say little about it. Nevertheless stroboscopic methods can sometimes be used with advantage in the college physics course, and it should not be difficult to find time for a discussion of the theory and some applications in the more advanced classes of the B. S. course. In the Bulletin for December 1930 (Vol. VIII, No. 2, p. 19), Fr. J. A. Blatchford, S. J., described a stroboscopic device for adjusting the speed of a Victrola disk and also an improved form he made for attachment to the sound disk of a moving picture machine. It may be worthwhile to supplement his article by discussing the principle of the stroboscope and giving some simple illustrations and applications. For further information the following articles may also be consulted. "Stro boscopes", "Instruments" for November 1931 (Vol. 4, No. 11, p. 581); "A Stroboscopic Frequency Meter", "The General Radio Experimenter" for November 1930 (Vol. V, No. 6, p. 5) "The Stroboscope" Ibidem, for December 1932, Vol. VII, No. 7, p. 1). The last article gives a discussion of the simple formulae involved. "The General Radio Experimenter" is published by the General Radio Company of Cambridge, Mass., and is sent free to those who request it.

The fundamental principle of the stroboscope is quite simple. If we view a rapidly rotating or vibrating body with ordinary light, it will evidently have a more or less blurred appearance. Usually it will be impossible to make out any details on the surface. If however either body be subjected to intermittent illumination of proper frequency, in a sufficiently dark room, we can make it appear to move as slowly as we wish, or even appear absolutely at rest. Thus suppose a white disk with a narrow black sector marked on it, revolves ten times a second. Suppose also that it is illuminated by ten light flashes a second, each flash occurring when the sector is passing through its upper position. The eye will see the disk with the sector always in exactly the same position. The ten images per second received on the retina will merge and the disk will appear at rest. The same thing will be true if the disk revolves two, three or, in general, n times as fast for it will make two or more complete revolutions between the flashes. If the disk has two sectors marked on it 180° apart, then for the same number of flashes, it will appear at rest when moving only half as fast, since for every half revolution the sectors occupy the same relative positions. In general the product of the number of sectors and the number of revolutions is equal to the light frequency. The apparent speed may be made as small as desired by making the light frequency slightly less than the number of revolutions per unit time. The disk will then move slightly more than 360° between the flashes. At each flash a sector will appear in advance of its previous position. To the eye it will appear to move slowly in the direction of rotation. On the other hand if the frequency of illumination is slightly greater than the angular velocity the sectors will appear to move slowly backward.

The fact that for a given frequency of light flashes there is only one speed (or some integral multiple of it) at which the sectored disk will appear at rest, makes the stroboscope a useful device for adjusting the speed as well as a delicate test of its constancy. The actual speed may also be measured accurately by the same means. Thus if the disk has A sectors and it appears at rest when there are F flashes per second, then it is making F/A revolutions per second. The article on "A Stroboscopic Frequency Meter" already referred shows how the frequency of a vacuum tube oscillator can be adjusted (audio range). A standard frequency oscillator operates a synchronous motor to which a sectored disk is attached. The speed of the motor is determined exactly by the source of power. A neon lamp is connected with the oscillator to be adjusted and illuminates the disk. The second oscillator is adjusted until the disk stands still. The same article describes and illustrates two disks composed of a large number of concentric white rings with black sections marked on them. Each corresponds to a definite frequency so that a large range is available. These can be purchased. The stroboscopic method of regulating or measuring speed has the double advantage of not requiring any complicated mechanism apart from the light source and of not absorbing any power from the moving body. Besides, slight irregularities are immediately revealed.

There are several ways of illustrating the principle of the stroboscope. A rotating sectored disk may be used as already intimated. We have a stiff cardboard disk about 14 inches in diameter with 108 sectors marked on it. This is attached to a Cenco Lecture Table Rotator. A fine filament Mazda lamp with alternating current may be used for the intermittent illumination, but some form of neon lamp is far superior as Fr. Blatchford states. The reason is that it follows practically instantaneously the variations in the impressed voltage, being completely extinguished when the latter drops below a certain value. The filament of an incandescent lamp on the other hand does not have time to cool sufficiently when the current drops to zero so that it always emits some light. Fr. Blatchford refers to a small ½ watt lamp. There is now a 2 watt lamp on the market costing about 75 cts. which can be inserted in any socket. It gives more light. If more illumination is desired, e. g. for a large class, a neon tube may be used. A few years ago on the occasion of a disputation paper in physics we borrowed some tubes and a transformer from Brink of Boston, maker of neon signs. We were allowed to keep one 28 inches long and 1¼ inches wide. It gives excellent results. Unlike the small lamp referred it requires high voltage. When a special transformer is not available, an ordinary small induction coil serves very well. It is only necessary to screw up the interruptor and connect the primary with the A. C. line with sufficient protective resistance in series. The tube is then connected to the secondary terminals. In any case the lamp or tube is set up in front of the disk in a darkened room. The Rotator is gradually speeded up until the disk appears to stand still. The contrast is quite marked. By varying the speed, the disk will appear to move slowly forward or backward. If a Mazda lamp is used there is a rather blurry effect.

Another demonstration, perhaps more striking, can be made with an ordinary electric bell. An intermittent light source of variable frequency is required. We use a stout cardboard disk 12 inches wide with four 3-inch circular holes cut in the quadrants. Four or more rectangular openings may be used instead of circles. The disk is attached to the Cenco Rotator and placed in front of the objective of a stereopticon. It is adjusted so that the light can pass freely through one of the holes. The electric bell, with or without the gong, is set up in front of the condenser and the shadow of the hammer is focussed on the screen. When the bell is connected with a couple of dry cells the rapidly vibrating shadow will be seen. The Rotator is then started and the light cut off at regular intervals. As the speed is gradually increased the image will move more and more slowly and finally come to rest. The contrast between the rattling or sounding of the bell and the stationary shadow on the screen is impressive. Light from a port-lumiere or some other source furnishing a bright parallel beam may be used instead of a stereoptican. The bell hammer is placed in the path of the beam and its shadow focussed by means of a simple lens. The interruptor disk is placed in the path of the beam as before.

A stroboscope is especially useful in the study of vibratory and wave motion. There are various types of model wave apparatus available which have the advantage of being under the control of the lecturer. But often they are quite artificial. When actual waves are shown they usually travel so fast that the details of the motion cannot be observed. Any device therefore which can slow them down, even apparently, is worth using. Two illustrations may be cited. When a stretched flexible string is set in vibration, two wave trains, one direct the other reflected, travel along it. The actual motion of any one of its particles will be the resultant of the two motions impressed on it. By varying the tension the string will vibrate as a whole or in segments. Both kinds of vibration may also be combined. To study the motion in detail, a white string is fixed in a clamp at one end and the other end is tied to the hammer of an electric bell (with the gong removed). An electrically driven tuning fork may be used. There is also a special apparatus on the market for producing vigorous vibrations in a long rubber tube. For most purposes however the bell works well. A strong parallel beam of light is directed along the string. We use a Cenco Arc Illuminator. A direct current arc should be used for stroboscopic experiments. The perforated disk already described is set up in the path of the beam. When the string is set in vibration, the familiar spindle-like segments can be seen under steady illumination. The disk is then set in rotation. Very striking effects are observed as the frequency of the light and the tension of the string are varied. The vibration of any portion of the string can also be studied by projecting its shadow on a screen by means of a lens rotating the disk as before in the path of the beam. It is interesting to project the hammer and the portion of the string near it. As a complement to this experiment, the motion of any particle may be shown by placing a piece of cardboard with a narrow verticle slit cut in it in front of some part of the string. The light is received on a rotating mirror from which it may be reflected on to a screen. The shadow of the small section describes a more or less complex harmonic curve. Steady light is used. Cf. Stewart, Physics, p. 351.

A second example is the study of ripples on the surface of a liquid. Reflected or transmitted light may be used. In the first case the ripples are produced on the surface of clean mercury by means of an electrically driven fork or some other suitable vibrator. A strong beam of light is directed upon the ripples and reflected upon the ceiling, or sent to a screen after reflection from a second mirror. A lens is interposed to produce a sharp image. For transmitted light water may be used. Several years ago Prof. Chaffee of Harvard gave a course of lectures at the Lowell Institute in Boston. They were illustrated with experiments, some of them being on wave motion. He made use of a vertical projector. A shallow vessel with a glass bottom containing water was placed on the projector and a parallel beam from an arc was reflected through the liquid and focussed in the usual way on a screen. A slotted disk driven by a variable speed motor was placed in the path of the beam near the light source. Ripples were produced by means of a special vibrator. Prof. Chaffee suggested the use of carbon tetrachloride instead of water. A suitable vibrator of small amplitude so arranged that various arms could be attached to it is very desirable for such experiments. I do not know of any on the market. There should be an arm with a single right angled pointer to produce a single wave train and one with two prongs to serve as two adjacent wave sources to show interference; also if possible one with a rake like attachment to illustrate Huyghens' principle.

We have used another method of demonstrating wave phenomena on water, making use of a glass bottomed box a home made wave generator and the stroboscope already described. A thin brass rod was soldered to the armature of an ordinary buzzer. The end of the rod was sharpened and bent at right angles. A similar right angled piece was soldered on to it so that it resembles a two pronged rake. The box is part of the Baker Wave Apparatus sold by the Central Scientific Co. It is mounted over two rods held in clamps and water put into it to a depth of one or two centimers. The vibrator held in a clamp is placed over it with one or two prongs touching the water. A right angled arc is placed under the box with the positive carbon vertical, thus furnishing a powerful point source of light. The Rotator is placed besides the lamp and the disk set horizontally with a hole directly over the arc. It must be fairly close so that light will pass freely through the water. A single or a double train of ripples can be produced. The most interesting effects are those due to the combined action of two wave trains. Regions of reinforcement and interference are produced. When the ripples are slowed up by the proper adjustment of the rotator the hyperbolic bands of maximum and minimum disturbance can readily be seen on the ceiling. Of course it is a refractive rather than a shadow effect.

In the "General Radio Experimenter" for December 1932 a new type of stroboscope is described. I recently had an opportunity to see it in operation. It was developed by Prof. H. E. Edgerton of the Mass. Institute of Technology. The light source is an inverted U shaped glass tube containing mercury vapor and having mercury electrodes at the lower ends. The light flashes are obtained by the successive discharges of a condenser across the terminals. They are short and brilliant lasting from 5 to 10 microseconds. The frequency is regulated by a special contractor whose speed is varied by means of a friction drive attached to a motor. Sixty cycle current can also be used. A rather elaborate electrical circuit is required, a Thyratron Tube serving as a sort of timing relay. This stroboscope is very effective. However it is rather expensive and cannot be used for projection on any scale on account of the diffuse nature of the light. Prof. Edgerton has used the tube to obtain some striking high speed moving pictures. No shutter is required. The film moves rapidly through the camera and a succession of images is impressed on it by the light flashes.

THE SECOND LAW OF THERMODYNAMICS

Rev. Joseph P. Merrick, S.J.

After the New Orleans meeting of the American Association for the Advancement of Science one of the press notices had it that Professor Bridgman of Harvard held that a kettle of water on a fire might freeze. As I had just read Bridgman's "Physics of High Pressures" the statement seemed contradictory with his previous position. So I wrote to him to find out what he did say. His statement follows:

"In reply to your letter of January 11, inquiring about by address in New Orleans, the quotation which you gave from the papers was exactly wrong. The particular point that I made in the lecture was that, although thermodynamic reasoning, as presented hitherto, has justified the expectation that a kettle of water might freeze when placed on the fire, nevertheless in my opinion there was a flaw in the logic so that one would have the right to expect such a thing to occur in the future only if it had already been observed to occur in the past, which certainly has never been recorded.

With regard to the application of the second law to interstellar space, my point was that the conditions are so different from the conditions on earth that logically any application of the second law must be regarded as a very great extrapolation and is accordingly very hazardous. I have no more reason than the next man to expect what may be the actual fate of radiant energy as it travels through space.

The complete text of my lecture will be printed in the Bulletin of the American Mathematical Society" . . .

It was a relief to know that he had not attacked the second law. For put, instead of the kettle, the three Hebrew youths, Sidrach, Misach, and Abdenago and for the fire the Chaldean furnace, and you make one of the outstanding miracles of all time merely one of those exceptions that occur eons after eons, if you will, but naturally.

Bridgman is a greater experimenter, perhaps the best there is in the domain of high pressures, and it is easy to see the realist conquering the theorist in all his work. It may be that in the "Operational Viewpoint" which he propounds he is excessive in his fear of theory but at least he has his feet on the ground and is a good antidote to men like Tolman who are often more speculative than the worst of the schoolmen. Bridgman has shown so many unexpected results and transformations and deformation due to high pressures that he has shown more clearly than anyone else almost the danger of extrapolation of results under ordinary conditions to conditions of extreme high or low pressures or interstellar space. There may be extended forces and phenomena there of which we are utterly unaware.

It might be well to review again the basis of the second law. The second law states that hot bodies tend to transfer heat to colder bodies so that viewing heat energy alone all bodies tend to a common temperature. The heat transfer may be by conduction, convection, or radiation, alone or together. The heat of a body from the physical aspect is simply the kinetic energy of the molecules which in the hotter body have a greater average speed than in the colder one.

Now apart from some rare instances in the history of revealed religion, a real conflict between fact and the second law has never been recorded in the universal and perpetual experience of mankind. There is not a single professor of physics who would not put all the blame on the student if after having made all proper corrections he found the boiling point of water under standard conditions to be 99.4° centigrade. And if he said he saw ice start a fire, he would be called a liar or an imbecile.

Rightly so. For if the second law were merely a statistical result permitting sensible deviations in particular instances, these deviations should at times manifest themselves. They have never done so. Insensible deviations we may and do admit. But when we are dealing with a trillion trillion averages as we do in the hundredth part of a gram of hydrogen then we say it must inhere in the very nature of converging probabilities when dealing with numbers so vast that the average phenomena must inevitably be the prevailing phenomena. The statistical or the most probable state is under such conditions always and a priori and necessarily the actual sensible state. We readily grant that some of the molecules in a piece of ice may at any instant have such kinetic energy which if it were the average energy might easily start a fire. But how far would these Sampson's get if herded and surrounded by a trillion Philistines? There would not even be a detectable change in temperature. Sensible deviations are permitted not to nature but to God.

Briefly before we knew that heat was a statistical state we knew that ice would not of itself burn wood and we'll be knowing it long after we have discovered that heat is a bit more than statistics. The mode of action reveals the essence and the essence is invariant when the action is invariant. Otherwise you have intellectual anarchy. Under the conditions for which it has been formulated, the second law of thermodynamics is invariant. It is a law of nature and its suspension is a miracle.

THE EXISTENCE OF MOLECULES

Rev. Joseph P. Merrick, S. J.

It has often proven helpful to have a summary of the various proofs and confirmations of the existence of the molecule for in such a summary is included a lot of physics and the cumulative argument shows how convincing our proof of their existence is.

Most of the following are culled from Perrin "Atoms". Please note that N stands for Avogadro's number, the number of colecules in a gram molecule of a substance. In some instances there is a complete divorce between theory and theory as for example the kinetic theory of gases versus the ratio of the farady to the electronic charge, in others the separation of theory from theory is only partial but sufficient.

1.	Vertical distribution of particles in concentrated emulsions	$N = 68 \times 10^{22}$
2.	Vertical distribution of particles in dilute emulsions....	68 " "
3.	Brownian movement displacements	64 " "
4.	Brownian movement rotations	65 " "
5.	Brownian movement diffusion	69 " "
6.	Critical opalescence of smoke, etc.	75 " "
7.	Blueness of sky	65 " "
8.	Diffusion of light in argon	69 " "
9.	Black body spectrum	61 " "
10.	Charges on microscopic particles	61 " "
11.	Projected radioactive charges	61 " "
12.	Radioactively produced helium	66 " "
13.	Radium lost radioactively	64 " "
14.	Radium energy	60 " "
15.	Viscosity and kinetic theory of gases	68 " "
16.	Ratio of faraday to electronic charge	61 " "
17.	Lattice structure of calcite crystals	62 " "

Confirmatory phenomena

18. Habitual expansion of matter when heated.
19. Sublimination, evaporation, vapor tension especially at eutectic point and allied facts.
20. Growth of crystals.
21. Divisibility of matter (gold leaf O. lmicron; fluorescein in water; thin films 1.1×10^{-7}cm, glycerin triolate)
22. Boyle's Law, Charles' Law, gas constant and absolute zero; laws of definite and multiple proportions, etc.
23. Saturation and hysteresis.
24. X-ray and electron-ray patterns of crystal lattices.

Friction, absorption, adsorption, porosity, occlusion, elasticity, 9 types of solutions, e. g. solid in gas, solid in liquid, and solid in solid; liquid in gas etc., osmosis, surface tenion, shear, the mean free path as determined by Born in 1920 and most of all by a direct study of positive molecular rays best exemplified by the Stern Gerlach experiment in which the ray itself is all but seen.

(Continued from page 203)

a piece of newspaper is placed over the items therein contained to serve as a protection during the time which intervenes between the checking out of one man and the checking in of another.

This scheme has been tried out at Boston College for the past year and so far seems to have fulfiled all the promises which we had hoped it would give.

SEISMOLOGY

WORLD'S FAIR, CHICAGO, ILL.

Fordham University Model Earthquake Recorder

REV. JOSEPH J. LYNCH, S.J.

Purpose

The purpose of the Model is to show the distant effects of an earthquake—how these distant effects are detected and how from these effects an earthquake can be located.

What is an Earthquake?

An earthquake is a sudden slipping of a portion of the earth's crust—a readjustment of the crust to a change of internal forces. A landslide is a readjustment of the crust on a very small scale. A snow slide on a sloping roof is an example on a still smaller scale. When snow on a sloping roof begins to thaw, the force holding it to the roof (causing it to stick to the roof) is lessened considerably and the slipping is a readjustment to this change of force—the snow moves until it finds a force which will hold it in place.

A slight readjustment of the earth's crust is going on nearly all the time at Niagara. From time to time huge boulders of rock fall into the water. The softer rocks and clays underlying the overhead rock become washed away by the spray of the Falls. The supporting force is thus removed from under this overhead rock and boulders of it fall in readjustment. The rock readjusts itself to the forces present. An earthquake is such a readjustment to changes of pressure—but a readjustment on a much larger scale. It is a readjustment taking place deep in the earth's crust down to the depths of a hundred miles or so. The changes of pressure underneath such blocks may be due to a multiplicity of causes—erosion and deposition—tidal forces, centrifugal force (indicated by the fact that earthquakes are confined to the equatorial belt) and numerous others beyond the scope of this pamphlet. An earthquake then is a sudden movement of a portion of the earth's crust.

Distant Effects

This sudden movement causes the whole earth to quiver. This quiver travels through the earth as ripples travel over a pond. It is not very noticeable but it has been noticed on the surface of mercury levels and still ponds. In fact attention was first called to its existence by the quiver noticed on such surfaces. But while not noticeable as a rule by our unaided senses, it may be made noticeable by a Seismograph.

Seismograph

The Seismograph may be called the microscope of the Geophysicist. It enables him to see and to measure this quiver of the earth at all points. It enables him to locate an earthquake from its quiver. The essential part of a Seismograph is a delicately supported pendulum. If the ground should quiver under such a pendulum, the latter because of its inertia (literally laziness) will not quiver. It will not respond to the earth's quiver for the same reason that none of us care to respond to the alarm clock in the morning. All bodies possess this inertia or laziness to motion. If a careless chauffeur starts up a car suddenly, the passengers are thrown backwards. Actually they do not move but refuse to move—they do not respond to the quick motion of the car because of their inertia and are left behind, i. e. stay still while the car moves forward—hence they are thrown backwards in the car. Similarly if the chauffeur jams on the brakes suddenly, the passengers are thrown forward. Because of their inertia they refuse to have their motion stopped so they continue forward while the car stops—hence they lurch forward in the car. We show this inertia in a personal way—we hate to go to bed but once there, we hate to get up.

When the earth moves suddenly then under a delicately suspended pendulum, the pendulum lurches backwards or forwards depending on the motion of the ground. We say it lurches—actually it stays still while the ground underneath it lurches. This slight motion of the pendulum can be magnified in many ways—mechanically by means of a system of levers—electrically by winding a coil round the pendulum and setting the latter up between the poles of a strong magnet—the slight motion of the coil across the magnetic field generates a current which can be amplified in many ways.

Sensitive Seismographs today magnify the motion of the ground about two thousand times. This magnified motion is recorded on paper by attaching a pen to the pendulum or its lever system (to lessen friction the motion is usually recorded on photographic paper by a light beam reflected from a mirror attached to the pendulum in place of the pen).

Such a Seismograph set up anywhere on the globe will be set in motion by the quivering of the earth due to an earthquake and will faithfully record the quivering.

We likened these quivers to ripples. They are ripples or waves in the earth. They are due to the elasticity of the earth and there are two kinds of them. The first is a Push Wave which compresses the earth as it travels—the other is a Shake Wave which tends to shake the earth particles from side to side as it travels. The Push Wave travels about five miles per second. The Shake Wave travels more slowly, about three miles per second. The Push Wave is due to the elasticity of volume of the earth—the Shake Wave to its elasticity of shape. We have something similar in the case of a lightning bolt—we have two distinct waves sent out, a lightning wave which we see and a thunder wave which we hear. The lightning wave travels much faster than the thunder wave, hence we always see the lightning before we hear the thunder. In fact we can estimate the distance of the lightning bolt by the number of seconds that elapse between the arrival of the lightning and the arrival of the thunder—each second putting the bolt a fifth of a mile away.

Distance of Quake

In a similar way we can estimate the distance of an earthquake from a Seismograph by measuring the number of seconds that elapse between the arrival of the Push or Primary Wave and the arrival of the Shake or Secondary Wave. A set of tables has been compiled giving the distance of the quake for each time interval in seconds.

In addition to the Push or Shake Waves, a third wave, a combination of the two, travels around the outside of the earth and arrives much later. It is not necessary for the computation of a quake's distance but it acts as a useful check since its speed is likewise known.

The Fordham Model

The Fordham Model is a pendulum of the horizontal type, i. e. the pendulum swings in a horizontal plane instead of a vertical plane. This type has many advantages over the vertical, chief of which is a much wider range of period. The swinging boom of the pendulum itself acts as a lever, the magnification depending on the length of the boom. The pendulum is set up on a platform to which the motion of the three earthquake waves, the Push, Shake and Surface or Long Waves can be imparted by an electric motor. As each wave "arrives" and shakes the table, the pendulum records the motion on paper. The time between the beginning of the Push and Shake Waves may be measured from the record if the speed of the drum can be known. From this time interval the distance of the quake can be determined. If the distance of the quake from three earthquake stations be known, the exact location of the quake can be determined by describing three circles on a globe, with the stations as centers and their distances from the quake as radii. The point of intersection of the three circles will be the center of the quake.

A PRELIMINARY STUDY OF MICROSEISMS IN MANILA

Rev. William C. Repetti, S.J.

Microseisms have held the interest of seismologists from the earliest days of instrumental seismology. Much time and labor have been devoted to their investigation and several explanations have been advanced to account for them. It has seemed evident to all investigators that there is a connection, more or less close, between atmospheric disturbances and microseisms.

Father Wessling, when in Buffalo, attributed microseisms recorded at Canisius to heavy seas breaking on the Buffalo breakwater. Klotz at Ottawa found that microseisms became strong at Ottawa when there was an area of low atmospheric pressure over the Gulf of St. Lawrence. Gutenberg traced the European microseisms to heavy seas breaking against the Norwegian coast. He also traced the North American microseisms to heavy seas breaking against the Labrador and Nova Scotia coasts. Banerji in India has recognized two kinds of microseisms, those associated with monsoons and those associated with storms. Father Gherzi of Shanghai who has taken a special interest in the microseismic storms of the group variety advances the opinion that they are due to pulsations set up by the "pumping effect" which exists at the center of a typhoon.

Microseisms are very conspicuous in the Manila seismograms during a typhoon and somewhat prominent during the NE monsoon. It is evident that it would be of great interest if the causal connection between these phenomena could be definitely ascertained. This is especially true in the matter of typhoons in which every means available would be made use of to forecast them or trace their path.

During the past year an investigation of the Manila microseisms was commenced. A period of several days was chosen when the NE monsoon was blowing steadily. Microseisms increased simultaneously with the increase in wind strength. They could not be ascribed to the effect of any wind near Manila, because there was none of any consequence. The wind itself could scarcely be the direct cause of the microseisms because the monsoon wind blows with great steadiness. Our conclusion is that the microseisms during the monsoon period are produced by the rhythmic, continuous beating of the sea on the coast at some exposed section where there is a rocky shore and rapidly deepening bottom. It is unfortunate that comparatively little is known of the east coast of Luzon north of the latitude of Manila.

It is quite certain that some of the microseisms recorded here are set up by the sea beating on the west coast of Luzon and possibly on the Manila breakwater. The building up of a strong southwest wind in the China Sea is always accompanied by microseisms in Manila. At times the micros appear on the seismogram before the wind makes itself felt in Manila. A number of instances have been observed in which the microseisms commenced when a typhoon reached such a position with reference to Manila that the southwest wind began to blow against the west coast of Luzon. In September of this year (1932) a typhoon passed the Philippines and went off in a general northwest direction towards Hong Kong. The southwest wind persisted along the west coast of Luzon for several days and the microseisms continued at Manila until the ground swell set up by the wind had subsided.

The microseisms in which Father Gherzi is particularly interested appear in connection with typhoons. They are of large amplitude, and show a decided beat effect, rising and falling in amplitude, the motion at times being practically nil. They are sometimes spoken of as the saw-tooth variety. The writer investigated several instances of these "beat" microseisms and endeavored to trace them to increasing wind and sea against the coast of Luzon. Some cases were found in which these forces seemed to be definitely excluded as causes. Some cases were then examined in the light of Father Gherzi's theory and more definite results were obtained. The barograms of the Feuss barograph for the period of the typhoon were examined. It was noticed the barometer curve took on an irregular wavy form during a portion of the period during which the Islands were under the influence of the typhoon. This irregular rising and falling of pressure represents the "pumping effect" which exists in a typhoon. These curves were plotted together with the microseismic amplitudes. It was then observed that the large amplitude microseisms began within a few hours after the appearance of the pumping effect on the barograms. A more thorough examination along these lines is expected to reveal some relation between the distance of the typhoon center from Manila, the intensity of the typhoon, and the time interval between the appearance of the micros and the pumping effect on the barograms.

Another relation observed was that the micro amplitudes are much greater when a typhoon crosses Luzon north of Manila than when one crosses to the south. This is presumably due to the fact that Manila is on the west side of Luzon and when a typhoon crosses to the north the southwest wind is then increasing and consequently increases the sea and its effect. Some instances have been observed in which a typhoon crossing Luzon almost exactly in a westerly direction has given rise to large amplitude microseims which began and ended rather abruptly. Further investigation may reveal that the effect may be due to resiliency in the great central plain of Luzon bounded on east and west by mountain ranges of igneous rock.

The conclusion with regard to the monsoon microseisms is that they are due to the rythmic beating of a heavy sea on a rocky section of the east coast of Luzon when the northeast monsoon is blowing with considerable force. These more or less regular micros are also caused by a southwest wind setting up a ground swell in the China Sea which beats against the west coast. The west coast is quite rocky in places and there is very deep water parallel to it and at a short distance only from the shore in several localities.

In regard to the large amplitude "beat" micros it is believed that the process is as follows. On the approach of a typhoon the wind increases and builds up a sea which causes the regular microseisms, particularly noticeable in Manila in southwest winds. The pumping effect of the typhoon produces another set of micros. When the typhoon approaches within a certain distance of Manila the micros produced by the sea and those produced by the pumping effect unite to give the large amplitude micros, with the beat effect due to differences of period.

The work done so far is merely of a preliminary character but the line of attack of future investigation appears to have been ascertained.

THE WOODSTOCK SEISMIC STATION

REV. JOHN G. TYNAN, S.J.

The "Woodstock Seismic Station" may sound strange to the ears of Ours, who have been accustomed only to the three big stations of the Province, but the Woodstock station has been in continuous operation over fifteen months now (April 1, 1933) and has already had the satisfaction of contributing data to the Jesuit Seismological Association. To date some forty quakes have been registered and interpreted—the last of which, the Long Beach tremblor of March 10th, was of sufficient amplitude and clarity to arouse the admiration of the Community and the enthusiasm of the staff. The Tokyo earthquake in the previous month was perhaps the strongest yet recorded and in connection with this we had for the first time the satisfaction of seeing our interpretation listed in the Preliminary Bulletin of the Jesuit Seismological Association. The Eastern Section, Seismological Association of America is at present manifesting interest in our equipment and its chairman is clamoring for a descriptive article for the Spring Meeting in Washington. We graduate our first student this June and if present plans do not miscarry, each year at least one third year philosopher will carry into the regency an elementary knowledge of and some practical experience in seismology.

(Continued from Page 172)

The Bulletin is a quarterly and is published in September, December, March and May of the scholastic year. With this present issue, we have completed ten volumes. In volumes VI, VII and VIII, two hundred and three articles were published. An index of these articles appears in Volume VIII, No. 4, May 1931. Since the beginning of the Science Bulletin about six hundred articles were published. Copies are sent to each member of the Association, to the libraries and reading rooms of our colleges and houses in all parts of the world.

(Continued from Page 204)

when the left index of the "C" scale lies to the left of the corresponding index on the "D" scale. It is on this theory of the slide rule that the method is based.

From this theory, a similar method for placing the decimal point can not only be drawn up for some of the other scales of the slide rule, but can as well be applied to the slide rule practice of the individual user on many of the scales.

RECENT BOOKS

The books mentioned in this column are recommended by our Science Professors as suitable for the Science Libraries.

BIOLOGY

Methods in Plant Histology (5th Revised Edition), by Chas. J. Chamberlain. Univ. of Chicago Press.

The Food of Protozoa, by H. Sandon. Misr-Sokkar Press, Cairo, Egypt.

Paramoecium. Das Pontoffeltierchen, by Hans Kalmus. Gastav Fisher, Jena, Germany.

An Introduction to Zoology, by Zeno P. Metcalf. Chas. C. Thomas, Springfield, Mass.

A Survey Course in General Biology, by James G. Needham. Comstock Publishing Co., Ithaca, New York.

Riddles of Science, by J. Arthur Thomason. Liveright, New York.

Fighting the Insects, by L. O. Howard. Macmillan & Co., New York.

A Naturalist in the Guiana Forest, by R. W. G. Hingston. Longmans, Green & Co., New York.

CHEMISTRY

The Catalytic Oxidation of Organic Compounds, by L. B. Marek & D. A. Hahn. Chemical Catalog Co., Inc., New York.

The Free Energies of Some Organic Compounds, by G. Sutton Parks & H. M. Huffman. Chemical Catalog Co. Inc., New York.

The Terpenes. Vol. II, by J. L. Simonsen. Macmillan Co., New York.

Jahrbuch der organischen Chemie, by Julius Schmidt, Vol. XVIII. Franz Deuticke, Vienna, Austria.

Die Struktur der Atomkerne, by Siegmund Stransky. Franz Deuticke, Vienna, Austria.

Our Mineral Civilization, by Thomas T. Read. Century of Progress Series. Williams & Wilkins Co., Baltimore, Md.

A Text-book of Physical Chemistry. Vol. I, by J. Newton Friend. J. B. Lippincott Co., Philadelphia, Pa.

Physical Chemistry for Students of Biology and Medicine, by David I. Hitchcock. Chas. C. Thomas, Springfield, Ill.

PHYSICS

Advanced Electrical Measurements, by W. R. Smythe & W. C. Michels. D. Van Nostrand Co., New York.

Theorie de la quantification la nouvelle mecanique, by L. de Broglie. Herman et Cie, Paris. Fr. 70 net.

Lehrbuch der Physik. (II Auflage) Mueller—Pouiilets, Band IV: Electrizitat and Magnetismus. Zweiter Teil, 1932; Dritter Teil, 1933. F. Vieweg & Sohn, Brunswick, Germany.

Theoretical Physics, W. Wilson.
Vol. I: Mechanics and Heat (1931).
Vol. II: Electromagnetism and Optics (. . . .).
Vol. III: Relativity and Quantum Dynamics (. . . .) .
London: Methuen & Co.

MATHEMATICS

Elementary Mathematics From an Advanced Standpoint, F. Klein. The Macmillan Co., 1932.

Almost Periodic Functions, A. S. Besicovitch. The Macmillan Co., 1932.

Projektive und nichteuklidische Geometrie, F. Schilling. Band I and II. Teubner, 1931.

Elementary Treatise on Differential Equations, A. Cohen (2nd ed., completely revised). D. C. Heath & Company, 1933.

Trigonometry, W. L. Hart. D. C. Heath & Company, 1933.

Introduction to the Theory of Fourier's Series and Integrals, H. S. Carslaw. (3rd ed., revised and enlarged). The Macmillan Company, 1930. $7.00.

Projektive Relativitatstheorie, O. Veblen. Berlin: Julius Springer, 1933.

Analytische Geometrie, L. Bieberbach. Leipzig: B. G. Teubner, 1932.

Lehrbuch der Funktionentheorie, W. F. Osgood. Leipzig: Teubner.
Band I: 1928 (5. Auflage).
Band II: 1te Lieferung 1929 (2. Auflage).
Band II: 2te Lieferung 1932.

Methoden der mathematische Physik, R. Courant & D. Hilbert.
Band I: 1931 (2. Auflage).
Band II: . . . . J. Springer, Berlin, Germany.

Synopsis der hoeheren Mathematik, J. G. Hagen, S. J. Berlin: F. L. Dames.
Band I, II, III: 1891-1906.
Band IV: Metrische Differentialgeometrie der Ebene und des Raumes: 1930.
(For an appreciation of Fr. Hagen and a review of the first three volumes, cf. Miller: Historical Introduction to Mathematical Literature (Macmillan). For a review of the fourth volume, cf. Jahresbericht der deutschen mathematiker Vereinigung, 1932.)

Report of the Committee on Hydrodynamics (Dryden, Murnaghan, Bateman). Bulletin of the National Research Council: No. 84; February, 1932. The National Academy of Sciences, Washington, D. C., \$4.50.

NOTE: Swets & Zeitlinger, Booksellers—Amsterdam: Keizersgracht 471, in their catalogue 48 (1932) quote prices on standard works which seem to be quite reasonable. Thus:

Synopsis (J. G. Hagen, S. J.) Vol. I-IV. 55 Guilders (\$22.00).

Die Differential—und Integralgeichungen—Ph. Frank & R. Mises (7th edition of Riemann-Webers Partielle Differentialgleichungen der mathematischen Physik). Vol. I and II 1925-1927. Cloth. 45 Guilders.

No definite information is given concerning binding of many of the books listed.

BOOK REVIEWS

A Textbook of Physical Chemistry. Vol. I. General Properties of Elements and Compounds. J. Newton Friend, D.Sc., Ph.D., F.I.C., Head of the Chemistry Department, The Technical College, Birmingham, G. B. J. B. Lippincott Co., Philadelphia, Pa., 1933 xii+501 pp. Frontispiece, 3 plates and 198 illustrations. 22×15.5 cm. \$7.50.

As the title implies, this work is intended to be a textbook for senior and graduate students in physical chemistry. Since the material covered is approximately the first half of the content of the average textbook, it is probable that the author has planned for two volumes. The advisability of a two-volume textbook, especially when not intended to be comprehensive, is doubtful. This first volume covers fundamentals, gases, liquids, solids, molecular structure and physical properties, solutions, and colloids.

One thing that will impress the reader is the easy and attractive style of Dr. Friend. It is a story that he writes for us and writes so invitingly that we are compelled to read on. But one must not be deceived into thinking that quantitative treatment is lacking. Mathematics aplenty is incorporated, but not in the bare form that dicourages the non-mathematically minded. The author adheres to the correct principle that, once concepts and ideas are grasped, the development in mathematical form is comparatively easy.

The arrangement of material will be found quite unusual. However, there is no consensus of opinion on this point, so criticism is scarcely justified. The reviewer would commend particularly the inclusion of two chapters on the fundamental laws and theories of chemistry. Many recent texts neglect this, but his experience is that, with many students, such a review of more or less familiar subjects in the light of a better back-ground is quite valuable. Dr. Friend's book is filled, to a very unusual extent, with descriptions of the experimental methods used to investigate the phenomena under discussion. It is abundantly and well illustrated and the three spectrum plates are excellent. There is no lack of tables. The index is quite detailed and cross-referenced. Especially noteworthy are the extensive discussions of the crystalline state, specific heat, surface tension, the parachor, and spectroscopy. The type is large and easy to read.

There is a complete absence of problems and literature references. It seems to the reviewer that omission of the first is serious in any work on a quantitative subject intended for use as a text. As to the second, students may, as suggested by the author, dig them out for themselves, but usually they will not. The work could be further improved by including a discussion of methods for determining atomic weights and especially of the application of X-rays to the investigation of crystal structure.

In conclusion, however, it should be emphasized that this an excellent book and one that any teacher or student will do well to have in his library.

M. M. H.

Physical Chemistry for Students of Biology and Medicine. David I. Hitchcock, Ph.D., Associate Professor in the Yale University School of Medicine. Charles C. Thomas, Springfield, Ill., and Baltimore, Md., 1932. xi+182 pp. 26 Figs. 14.25×23 cm. $2.75, postpaid.

The purpose of the book is to bring to the student an understanding of the language of physical chemistry and a knowledge of that part of physical chemistry involved in the appreciation of modern biological research. The treatment is elementary in character and not intended to equip the student for advanced work without further study of the subject. In this connection, the author has succeeded in presenting the subject in such a way that the student proceeding to further study will not have to unlearn what he finds in this text. The author is careful to point out, for example, that many of the laws stated are approximations and that more exact considerations lead to more complicated equations.

The reviewer feels that if in chapter 4 (Solutions of Electrolytes) the author had gone one step farther in discussing the quantity α, calculated from the conductivity ratio of Arrhenius, and had pointed out that the ionic mobilities are dependent on the ion concentration, his treatment of strong and weak electrolytes would have been improved. An objection might be taken to the statement on page 69 that "A concentrated solution of a strong acid or base is a good buffer. . . ."

On the whole, the author's treatment is very successful and should undoubtedly appeal to the teachers of premedical and biological students.

M. K., Jr.

NEWS ITEMS

ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF JESUIT SCIENTISTS

Biology section: Tentative Program of the Symposium on Bio-Philosophical Theories.—The object of the Symposium is to present briefly but comprehensively the current trends in bio-philosophical thought, many of which are showing tendencies in the direction of our system. The Professors of Psychology have been cordially invited to attend.

Vitalism

1) The Scholastic Vitalism.
2) Multiplicity of Forms.

NEO-Vitalism

3) The Entelechy of Driesch.
4) The Vitalism of H. W. Carr.
5) Woltereck's 'Biological Field.'

TELEOLOGICAL MECHANISM

6) Henderson's New Teleology.
7) The Neo-Mechanism of Needham.

ORGANICISM

8) Claude Bernard and Organicism.
9) The Unity of the Organism—Ritter.
10) E. S. Russell and the Organismal Theory.
11) The Organicism of Woodger.
12) The Organism as a Whole—Loeb.
13) Eldridge on the Organization of Life.

HOLISM

14) Smuts' Holism.
15) The Holism of J. S. Haldane.
16) A Catholic Holism—Mgr. Kolbe.

EMERGENT EVOLUTION

17) C. L. Morgan & Emergent Evolution.
18) W. M. Wheeler on Emergence.

CREATIVE EVOLUTION

19) Bergson's 'elan vital'.
20) The Creative Evolution of C. C. Hurst.

MNEMONIC THEORY

21) Rignano and the Mnemonic Theory.

MECHANISM

22) Hogben on Living Matter.

23) The Mechanism of T. H. Morgan.

The following are seme of the more important books recommended for an introductory study of the bio-philosophical systems and theories to be discussed in the symposium.

Vogel (ed), Psychology and the Franciscan School. Chapter on Plurality of Forms. Bruce & Co.

Driesch, Science and Philoshophy of the Organism. 2nd ed. A. and C. Black, Ltd. London.

Carr, H. W., The Nature of Life. Discussion Brit. Assoc. Cape Town, 1929.

Woltereck, Grundzuge einer allgemeiner Biologie, etc., 1932.
Stuttgart: Ferdinand Enke (see Nature Dec. 17, 1932).

Henderson, L. J., The Fitness of the Environment. Macmillan.

Needham, Jos. Man a Machine. W. W. Norton, 1928.

Ritter, W. E. The Unity of the Organism. Badger, Boston, 1919.

Russell, E. S. Interpretation of Development and Heredity. Oxford U.

Woodger. Biological Principles. Harcourt, Brace & Co.

Loeb, Jacques. The Organism as a Whole. Putnam.

Eldridge. The Organization of Life. Crowell.

Smuts, J. C. Holism and Evolution. 2nd ed. Macmillan.

Haldane, J. S. Philosophical Basis of Biology. Doubleday, Doran, 1932.
Mechanism, Life and Personality, 2nd ed. Dutton, 1923.

Kolbe, Mgr. A Catholic View of Holism. Macmillan, 1928.

Morgan, C. L. Emergent Evolution. Henry Holt.

Wheeler, W. M. Emergent Evolution. W. W. Norton.

Bergson, Henri. Creative Evolution, trans. by Mitchell. Macmillan.

Hurst, C. C. Mechanism of Creative Evolution. Macmillan, 1933.

Rignano, Eugenio. Man Not a Machine. Keegan Paul. London, 1926.
The Nature of Life. Harcourt, Brace & Co.

Hogben. The Nature of Living Matter. Alfred Knopf.

Morgan, T. H. The Scientific Basis of Evolution. W. W. Norton, 1932.

WOODSTOCK COLLEGE. BIOLOGY DEPARTMENT

The department wishes to renew its offer to supply fruit flies in moderate amounts. The following are the varieties in stock at present:

D. funebris; D. melanogaster: Wild, White Eye, Eosin Eye, Garnet Eye, Bar Eye, Brown Eye, Sepia Eye, Peach Eye, Vermilion Eye, Attached X, Curly Wing, Miniature Wing, Vestigial Wing, Forked Bristles; Combinations—White Bar Eye, Eosin Miniature, Brown Vestigial, White Miniature. Further information may be had by writing to Mr. James L. Harley, S.J.

Those to be ordained at Woodstock—members of the Scientists Association—Leo F. Fey and Charles H. Rohleder—Physics Section; James L.

Harley—Biology Section; Gaston Denis, of France, who taught Physics at Tientsin, attended the meetings, but is not a member.

The Community had the opportunity of hearing two interesting lectures in February. The first, on February 9th, was given by Major-General Harry L. Gilchrist, U.S.A., Chief of the United States Chemical Warfare Service. His subject was ''Chemical Warfare''. The second, on February 10th, was about the ''Archaeology of the Holy Land'', and was delivered by Prof. (Dr.) William F. Albright, of Johns Hopkins University. Several scientific movies were also shown recently, on Surface Tension (Langmuir), the Steam Turbine, The Hottest Flame in the World (Langmuir), and other subjects.

The Chemistry Department recently acquired a Klett Bio-Colorimeter, which is being used in problems of sulfur research. Work is being carried on in the laboratories on the cystine and sulfur content of human epithelial structures.

Father John Brosnan, S.J., is at present giving a course in photography and the making of lantern slides to the philosophers.

LOYOLA COLLEGE, BALTIMORE, MD. CHEMISTRY DEPARTMENT

The lectures recently delivered by non-resident professors to the Loyola Chemists' Club were: March 7th: Dr. Donald H. Andrews, Professor of Chemistry at The Johns Hopkins University; ''Thermal Motion in Molecules.''—March 14th: Dr. Herbert Insley, National Bureau of Standards, Washington, D. C.,; ''Production of Synthetic Crystals at High Temperatures.''—April 4th; Dr. Joseph C. W. Frazer, Director of the Chemistry Department at the Johns Hopkins University; ''Heterogeneous Catalysis.''—April 25th; Dr. J. H. Shrader, Director of Research of the National Dairy Products Corporation; ''Utilization of Science in the Dairy Industry.''

The last meeting of the scholastic year will be held on Tuesday, May 9th. At this meeting the lecture will be delivered by Dr. Walter A. Patrick, Professor of Chemistry at The Johns Hopkins University. His subject will be: ''Colloidal Chemistry.''

BOSTON COLLEGE. CHEMISTRY DEPARTMENT

On March 31st, Mr. John T. Ryan, Professor of General Chemistry, spoke over Station WAAB and the Yankee Network, on the subject of ''Chemistry in Medicine.''

On April 7th, Father Joseph J. Sullivan, S.J., gave a talk on the ''Story of Aluminum.''

Students in Junior B. S. have been attending seminars in Colloid Chemistry as a supplement to the first semester work. Some of the topics taken up are as follows: Sedimentation, Molecular Orientation, Smokes, Properties of Gels, Adsorption.

GEORGETOWN UNIVERSITY

At the Founders' Day Exercises on March 25, Father W. Coleman Nevils, S.J., conferred first honors and awarded the medal of the Angelo Secchi Academy of Science on Dr. William Holland Wilmer of the Wilmer Ophthalmological Institute of Johns Hopkins in Baltimore. Dr. Wilmer, who is an honorary Doctor of Laws from Georgetown, served 19 years as Professor of Ophthalmology in the Georgetown Medical School before taking up his work at Johns Hopkins. Father Angelo Secchi, S.J., was one of the greatest astronomers and meteorologists of his age, and was especially noted for his classification of stellar spectra, his photographic proofs of the existence of solar prominences at the time of total eclipse, his investigation of the spectra of Uranus and Neptune, and his invention of the meteorograph. Father Secchi came to this country after the Revolution of 1848, and taught physics at Georgetown for one year, and made original researches in electricity. As a result of this, he composed a treatise called "Researches in Electrical Rheometery", which was published in 1852 in the Smithsonian Contributions to Knowledge.

GEORGETOWN OBSERVATORY

Interest in the Georgetown Eclipse Photographs is still widely manifest. Among recent requests for prints, lantern slides and transparencies may be mentioned those of the Buffalo Museum of Science, the Case School of Applied Science, the Chicago Camera Club, the Adler Planetarium and Astronomical Museum, etc. Copies of the photographs will be used as illustrations in the forthcoming Warner Memorial Lecture published by the Warner and Swasey Observatory of the Case School of Applied Science. The Chicago Camera Club has as its assignment the main photographic exhibit of the Century of Progress Exposition, and will display two 11 inch x 14 inch transparencies of the Georgetown plates. The Adler Planetarium is assembling negatives from all the leading observatories in the world, including Yerkes, Mount Wilson, Meudon, Greenwich, Georgetown, etc., to complete their exhibition of astronomical photographs. The whole lower floor of the building is being completed, an auxiliary lecture room accommodating 170 is being installed, and the museum space is being trebled. The dedication is planned for the time of the meeting of the American Astronomical Society in June. The Adler Planetarium will be the astronomical center of the Century of Progress Exposition. Its director, Dr. Philip Fox has requested transparencies of our eclipse plates for permanent display there. The National Academy of Science will also display a five foot by three foot enlargement of the Georgetown eclipse pictures.

Father Paul A. McNally, S.J., Director of the Georgetown Observatory, has given illustrated lectures recently on "The Universe in which We Dwell" to the Lions' Club of Silver Springs, Maryland, and to the faculty of Armstrong High School in Washington.

SEISMOLOGY DEPARTMENT

As a part of its Scientific series, Washington's Station WOL on April 4th broadcast an account of "Seismological Research at Georgetown University". On February 11, Father Frederick W. Sohon, S.J., Director of the Georgetown Seismological Observatory, delivered a lecture before the Philosophical Society of Washington, on "A Comparison of the Seismograph and the Radio Receiver". The lecture will be published in the Journal of the Washington Academy of Sciences.

On April 28th, Georgetown was host to the Eastern Section of the Seismological Society of America and the American Geophysical Union, meeting in joint session morning and afternoon.

PORTRAIT OF THE LATE FATHER TONDORF, S. J.

Dr. Michael Mullaney who has been for the last eleven years President of the Providence Group of Georgetown Alumni has announced that the Providence Alumni have commissioned Wilfred I. Dumphiney of Providence, a well known portrait painter of New England, to paint the portrait of the late Father Francis Tondorf, S.J., so long connected with the University and the founder and first director of the Georgetown University Seismological Department until his death two years ago.

The Providence Alumni were for many years interested in Father Tondorf's work at Georgetown and on more than one occasion made generous contributions towards the purchase of seismological apparatus for Father Tondorf's observatory.

The presentation of the oil painting will take place at the Commencement exercises next June.

MEDICAL SCHOOL

Dr. Morgan Re-elected

At its annual meeting in Montreal early in February the American College of Physicians unanimously re-elected Dr. William Gerry Morgan, the distinguished dean of the Georgetown Medical School, as Secretary-General of the College. In addition to this Dr. Morgan was placed upon the executive council. Dr. Morgan was formerly President of the American Medical Association; he is also well known as a stomach specialist. At the Medical School, besides his activities as Dean, Dr. Morgan is Professor of Gastro-Enterology.

Barton Fellowship

It was recently announced that according to the terms of the will of the late Mrs. Minnie Quinn Carter, a sum of $16,000 was left to the Georgetown Medical School for the purpose of establishing a fellowship to be known as the Barton Fellowship. Mrs. Carter was the widow of the late Dr. Wilfred M. Barton (M. D., '92), the distinguished physician and writer on medical topics. Dr. Barton's career is well known. During the late war he was a member of the Medical Advisory Draft Board. Later he was Associate Professor at the Georgetown Medical School and Attending Physician to Georgetown University Hospital. At one time he was President of the Medical Society of the District of Columbia. He was the author of "Modern Medicine," "A Thesaurus of Medical Words and Phrases," "A Manual of Vital Function Testing Methods and Their Interpretation," "Therapeutic Index and Prescription Writing," and "The Road to Washington," as well as numerous articles in current periodicals.

University Again Honored

The American College of Physicians meeting at Montreal elected Dr. Wallace M. Yates (M. D., '21), Governor for the District of Columbia. Dr. Yates, who is Chief of the Department of Medicine of the Georgetown Medical School, is the youngest member of the College of Physicians ever to receive this honor. Dr. Yates was formerly Assistant Military Instructor to the Washington High School cadets.

The Kober Foundation Awards for 1932

Announcement has been made recently by the Directors of the George M. Kober Foundation of the University that the annual bestowal of honors of the Foundation will be made this year to Dr. Alfred Newton Richards, Professor of Pharmacology at the University of Pennsylvania, and Dr. Rolla E. Dyer, of the U. S. Public Health Service, in recognition of their outstanding scientific achievements in the course of the year 1932.

Dr. Richards will receive the Kober Gold Medal in acknowledgment of his medical research in diseases of the kidneys, his selection having been made by the Association of American Physicians. Dr. Dyer was the choice of the Association of Military Surgeons of the United States as Kober Lecturer for 1933. As assistant-director of the National Institute of Health, Dr. Dyer conducted the Public Health Service's typhus fever investigations.

Dr. Dyer only recently recovered from an attack of typhus with which he was infested last October in his laboratory, his own case affording conclusive demonstration that the virus of this dreaded malady can be transmitted by the bite of a rat flea. The doctor's act in risking his life in the cause of science attracted the world-wide attention of physicians at the time and from his bed-side in the naval hospital in Washington he resumed active direction of the investigation.

Owing to the fact that the Association of American Physicians will hold its convention in Washington on May 9, the medal will not be presented to Dr. Richards until then.

The Kober lecturer last year was Dr. Ales Hrdlicka, curator of anthropology of the Smithsonian Institute, who recounted the researches into the medical history of the North American Indians. The medalist was Dr. Elliott Proctor Joslin, diabetes expert of Harvard University.

As was mentioned in a recent issue of *The Journal*, Dr. George M. Kober, who was for many years the much esteemed Dean of the Medical School of Georgetown University, established in 1923 an endowment fund of $16,000, the income of which was to be used for the creation of a scholarship in the Medical School, for a gold medal to be awarded annually to a member of the Association of American Physicians who had contributed most to the progress and achievement of the medical sciences and for providing an annual course of lectures by outstanding physicians noteworthy for their contributions to the advance of medical science or preventive medicine.

REGIS HIGH SCHOOL.—The Regis Pasteur Chemistry Society. Rehearsals for the annual Chemistry Demonstration scheduled for May 2nd are now in progress, under the direction of Mr. Thornton, the Moderator. Rev. Francis W. Power, S.J., delivered a lecture to the Chemistry Society on March 10th; his subject: "Explosives." Dr. Leo K. Yanowski of Fordham University will lecture on April 24th: "Chemical Warfare Gases and Their Peacetime Uses." A visit was made to the Borden Milk Products laboratories in Brooklyn on March 31. A motion picture: "Scientific Care and Handling of Milk" will be shown in the near future.

BULLETIN OF THE AMERICAN ASSOCIATION OF JESUIT SCIENTISTS

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N. B. Number ONE of each volume contains the Proceedings of the Annual Meeting.

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