THE STREAM OF PLANETOIDS.

A NEW LAW FOR ITS LOCATION.

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THE history of the planetoids between the orbits of Mars and Jupiter has passed through various surprising stages. The most notable departure which changes the accustomed notion of our planetary system is the discovery in 1906 and 1907 of planets which are not restricted to the zone between Mars and Jupiter. For this reason a glance at the development of our knowledge of this stream of planets may not be amiss at this time.

In the first place, the planets known for ages—Mercury, Venus, Earth, Mars, Jupiter, and Saturn—are so arranged that the interval between any two consecutive orbits, passing from within outward, almost exactly doubles. This phenomenon was first emphasized by Titius, professor at the University of Wittenberg, and is consequently known as the "Series of Titius." However, between the orbits of Mars and Jupiter the distance was so great that at this point a member of the Series of Titius was wanting. Indeed, Kepler, in his "Mysterium Cosmographicum" of 1596, had introduced at this gap a regular body as the symbol of an undiscovered planet. When Herschel (1781) discovered Uranus beyond Saturn, it came to light that this planet also continued with exactness the Series of Titius outwardly. Consequently, this series, although without a mathematical basis, gained in respect, and at the end of the eighteenth century the conviction grew with astronomers that between the orbits of Mars and Jupiter there was another planet. So in 1799 there was formed among them an association for the purpose of searching for the missing planet. It was desired to include Piazzi, the deserving director of the observatory at Palermo, in this group. But before he learned of this purpose, he found on the first day of the nineteenth century the sought-for planet, without, however, immediately recognizing it as such. In fact, in the course of his observations upon the fixed stars, a contradiction had come to light, and this manifested itself notably in the circumstance that a little star, first observed on January 1, 1801, of the eighth magnitude, had a somewhat different position on January 2, and during the following days advanced in the same manner. He followed the wandering star until the middle of February, and then, when it had disappeared in the evening twilight, sent its calculated positions to the astronomer Bode by mail to Berlin, where the letter arrived months afterward, having been delayed in transmission across the Alps by the disturbances of war. Piazzi spoke in his letter of a star-like "comet," which he had discovered. For the discovery of a planet had, apart from Uranus, never yet occurred. Consequently, this lay outside the realm of consideration. It soon transpired that the calculation of the orbit of the new celestial body could not be adjusted, for the observations permitted harmonization with no sort of parabolic cometary orbit. Then the supposition arose that it was a planet, and that it had an elliptical, circular-like orbit. But how was such a path to be calculated? The case had never yet arisen that a planet, which had a relatively rapid motion, which had been under observation for a short time, and the orbital velocity of which was unknown, required the calculation of its orbit. For Uranus, the only hitherto discovered planet, had (on account of its great distance) such a slow motion, and (on account of its high degree of brightness as a star of the sixth magnitude) such a long period of visibility, that it was easy, after it had disappeared from sight behind the sun, to pick it up again in the nocturnal sky of the following year, even without orbital calculation.

At this juncture, Karl Friedrich Gauss, but twenty-four years of age, proposed to himself the problem of calculating an elliptical orbit from the observations, and solved it, in that he devised an entirely new method, which thereupon was applied in all the following planetary discoveries, and thus played an important part in the astronomy of the nineteenth century. In accordance with his calculation of the orbit, the wandering star was picked up again on January 1, 1802 (exactly one year after its discovery), by Dr. Olbers at Bremen in an entirely different part of the sky and in the midst of many fixed stars similar to it. It was recognized again as a planet on account of its advance from night to night. Its orbit lay between that of Mars and Jupiter. It thus proved to be the hitherto missed and long-sought-for member of the Series of Titius. Piazzi named the new planet Ceres, after the mythological Sicilian goddess of protection, and gave her the sickle for a calendar symbol.

Upon observing Ceres further, Olbers found on

March 28, 1802, a second little planet, Pallas. Harding discovered (1804) Juno as the third, and Olbers (1807) Vesta, the brightest of all the planetoids, as the fourth—all lying between the orbits of Mars and Jupiter. There were thus, in contradiction to the Series of Titius, instead of one planet, four present in this zone. The following decade brought no further discoveries.

In the meantime, an astronomical amateur, Postmaster Hencke at Driesen, was searching with his telescope the quarter of the sky lying opposite the sun, year in, year out, night by night. He would map all the little stars and compare them again in the following nights. Although Prof. Encke at Berlin repeatedly admonished him that his efforts would remain unrewarded, he was not discouraged, and at last (1845) he found a new planetoid, to which (as well as to his daughter) he gave the name Astræa, and in 1847 a second, Hebe. Since then, no year has passed without the discovery of one or more new planets. This may be attributed not only to the example of Hencke, but also to the perfecting of the telescope, and to the publication of printed special star charts upon the basis of the localizations of numerous fixed stars. Thus one could enumerate in the year 1868 100 little planets; in 1879, 200; 1890, 300; 1895, 400; 1903, 500; and 1906, 600. Consequently, instead of one looked-for planet, a complete stream is present between Mars and Jupiter.

The zeal of the astronomers directed itself toward the observation of the numerous newly-discovered heavenly bodies. And all considered, it was an honor to take part in the calculations. At the same time, that varying quarter of the ecliptic which lies opposite the sun, and in which the planets reach their "opposition," and therewith their perigee and greatest brilliancy, was searched by astronomers for new ones. As the most fortunate discoverers are to be mentioned Hind (at London), Goldschmidt, an amateur (at Paris), Gasparis (at Naples), and Robert Luther (at Bilk near Düsseldorf). Chacornac and the brothers Paul and Prosper Henry discovered at Paris, during the construction of stellar charts of the zodiac, a number of planets among the numerous charted small fixed stars. From America, Watson at Ann Arbor, and C. H. F. Peters (born in Holstein) at Clinton astonished the world by their numerous discoveries. But Johann Palisa should be named in advance of all. Gifted with an excellent memory for star groupings, he discovered 83 new planets, the majority with a small telescope while director of the observatory at Pola. Later he moved to Vienna, where large refractors were available. But the number of small stars now becoming visible changed the accustomed groupings, and thus hindered rather than favored the further discovery of new planets. In Vienna he now made himself especially serviceable by following up the faint planets already discovered.

Planetary calculations have brought to astronomy many good methods and devices, and it must be considered as an especial triumph of science that we are able to recognize and find again with the aid of orbital calculation so many wandering stars, similar to one another and to the fixed stars. According to the method used by Gauss, they are sought, and betray their planetary character (if their position is measured twice during an evening within the interval of an hour) through their proper motion. In connection with the repeated appearances of the same planet, the mathematician must also allow for the "disturbances" which Jupiter and Saturn exercise through their attractions. This apparently difficult task is accomplished, following the example of the Berlin astronomer Encke, by means of the elegant method of mechanical quadrature, in that in the integrations of the differential equations the literal calculation is replaced by a numerical one. The astronomical Recheninstitut at Berlin acts as the official center for all these calculations, and publishes yearly in the Berliner Astronomisches Jahrbuch, the ephemerides of the planets, i. e., the tables which state from day to day their position in the sky. In this way, Germany's capital has become the center for the care of the planetoids.

According to the minute measurements of Barnard, Vesta (No. 4) and Ceres (No. 1) have each a diameter of 652 kilometers (405 miles), while Pallas (No. 2) has a diameter of 518 kilometers (322 miles).

The rest appear as mere points, and are immeasurably small. However, Weiss estimates, having regard to their brilliancy, the largest of them at 342 kilometers (212 miles) and the smallest at 16.14

and 10 kilometers (10 and 6.2 miles) in diameter.

There is no doubt that many small bodies are in motion among them whose diameters are of 1 kilometer (3,281 feet), of perhaps 1 meter (39.37 inches) and even of 1 millimeter (0.039 inch); and that the majority, on account of their faintness, are not visible to us. But do we not see in the winter a weak shimmer of light opposite the sun—the so-called "reflection of the zodiacal light"? This may be explained most simply by the reflection of the solar light from many little bodies; thus, from the well-nigh dust-like stream of the small and smallest planets, every one of which reaches its relatively greatest brilliancy at its opposition with the sun. These little bodies, on account of their slight power of attraction, can have no appreciable atmosphere and no bodies of water. Besides, they cannot markedly vary from the spherical form.

They are of no immediate use to mankind. Their orbital calculations can be used neither for the determination of time nor for the guidance of navigation. But the ideal beauty of these planets is that their reappearance is continually a test of the correctness of the calculation, and that they continually anew exhibit the validity of Newton's law of the universal attraction of all bodies.

Highly theoretical investigations have been carried out by Hansen, Glyden, Poincaré, and George Darwin, which have gained from orbital computation continually new points of view, and have led to beautiful mathematical ideas. Here belongs the question as to the simple relations of the times of revolution of a planet and of Jupiter as the most important disturbing planet, or the so-called libration of the orbit, as it comes to light in some measure with Hecuba (No. 108) and with planets of the Hecuba type. The value of the little planets is thus not to be sought upon the practical, but upon the theoretical side. The most beautiful thing in astronomy, its crown, are the mathematical laws which result from computation. Bessel said, and not with injustice, that astronomy presents to mathematics the worthiest and most exalted tasks, and their solution has resulted repeatedly in an "elegant" method, if one may here employ a customary mathematical expression.

But the trouble and time which hundreds of planets uninterruptedly required for their rediscovery and the correction of their orbits, are so considerable that the question was presented whether the gain was worth all the trouble. So, in the eighties of the nineteenth century, a party of astronomers demanded that a choice be made of the planets, and that only a part be followed up with accuracy, but that the rest (since indeed they apparently showed merely the same phenomena) be abandoned without attention. But surely that would not have lessened the labor. For, since one was unable to forbid the discovery of planets, it would have led to this, that the majority of the planets would be lost and would be continually discovered over again. Prof. Tietjen at Berlin found a middle course. Since 1891, he abandoned the yearly ephemerides (tables which gave the course of the planets during the entire year), and stated merely in one line, for each planet, time and place of opposition and the daily variation in its position. For selected, important, and interesting little planets, opposition ephemerides were printed, which gave the position of the planets daily with exactness for six weeks of their best visibility.

This economy was necessary, for in December, 1891, Max Wolff at Heidelberg began the photographic observation and discovery of the little planets, and this has resulted in an especially rich gain. Repeated and hour-long exposures of the photographic plate—in connection with which the telescope follows by means of clockwork the stellar position, ever changing during the course of the night with respect to the horizon, and in connection with which changing position the errors of the clockwork may be corrected by means of a precision screw—permit the fixed stars to register themselves upon the plate as points, the moving planets as short faint strokes. And these latter are discovered by means of the microscope after development and fixing. In this way more planets have been discovered in Heidelberg since 1892 than before. Charlois at Nice emulated Prof. Wolff in that he applied the same photographic method. Thus there has begun since 1892 the new era of astronomical photography.

The increase of the discoveries by means of photography since 1892 has induced astronomers to introduce

provisional designations. Up to this time all the planetoids had—following the example of the first, Ceres—been designated with feminine, above all with mostly mythological and classical names. Instead of the calendar symbols (sickle of Ceres, etc.) the natural numbers had long since been introduced; as far as possible arranged according to the time of discovery.

Since 1892, newly-discovered planets have received provisional designations of the letters A, B to Z; AA, AB to AZ; BA, etc., to ZZ; and with the number of the year preceding. Only if it has once been established that they could be observed sufficiently long to guarantee finding them again, and that they are identical with none of the earlier planets, do they receive the next numeral and name, and thus become included in the system. In this manner is avoided unnecessarily increasing the lost planets of the system. In 1907 the crucial moment has come in which the planet ZZ has been discovered, and the series of provisional designations begins again.

Up to nine years ago, all the 432 planetoids moved in the zone between the solar orbits of Mars and Jupiter; and, indeed, all with same right-handed motion. Consequently, no little attention was attracted when on August 13, 1898, Witt at the Urania at Berlin photographically discovered a planet with an unusually rapid motion. The computation of its orbit showed great proximity to the earth and a mean solar distance of 1.46 astronomical units; thus less than that of Mars (1.52). In astronomy the mean solar distance of the earth is taken as unity. Was this celestial body to be counted in with the stream of planetoids between Mars and Jupiter?

Since the possibility existed that still other planets might be discovered which were not confined to the zone between the orbits of Mars and Jupiter, it was determined to include it indeed with the planetoids with the numeral 433, but to distinguish it by the masculine name Eros.

Two months later Wolff, still at Heidelberg, discovered the planet Hungaria (No. 434). This, next to Eros, is with its solar distance of 1.94 units the innermost planet of the stream. Its orbit lies, however, entirely in the zone beyond the orbit of Mars.

Eros has a rather eccentric elliptical orbit, and thus approaches at the time of its perihelion three times as near to the orbit of the earth as Mars and the nearby planetoids. Through this circumstance it acquires a highly practical significance in respect to the determination of the true size of the entire planetary system. From the laws of the orbits is found, in fact, very accurately (to six decimal places) the relations of the planetary distances. On the other hand, these distances themselves are very little known. They are inversely proportional to the solar parallax (8.80 sec.), of which one can be confident of but two decimal places. By means of observation of the transits of Venus, of observation of the nearer planetoids, of Mars, of the velocity of light, and of the parallactic lunar equation, great pains were taken in the last century to determine with more exactness the solar parallax, and thus the extent of our entire planetary system. Now it appears that the observation of Eros yields this quantity with three times the exactness of the earlier methods, and that nothing else than the observation of the lunar orbit for the determination of the parallactic equation can compete with it. Thus the discovery of Eros performs a useful service for astronomy.

Just as Eros goes beyond the zone between the orbits of Mars and Jupiter toward the inside, so three lately-discovered planets do so toward the outside; though, to be sure, to only a small degree. These have also received masculine names.

In the first place, let it be stated that the mean solar distance of Jupiter amounts to 5.203 units. On February 22, 1906, Wolff at Heidelberg found the planet TG (No. 588), Achilles, mean solar distance 5.253, eccentricity 1/7. On October 21, 1906, his assistant Kopff discovered, at the same place, VY, Patroclus, mean distance about 5.204, eccentricity 1/7. On February 10, 1907, the same person found XM, Hector, with 5.278 mean distance and 1/27 eccentricity. These three heroes of Troy play, in addition, a noteworthy part through the fact that their right ascensions differ from that of Jupiter about 60 deg. Sun, planet, and Jupiter form what is thus almost an equilateral triangle. Now, Lagrange showed that the special case of the problem of three bodies is capable of mathematical solution when the three reciprocally attracting bodies form an equilateral triangle. They would then describe about each other, as well as about their center of gravity in the mathematical sense, similar ellipses. In this process, they would be able to approach and recede from each other, but in such way that the triangle, at whose vertices they were, would continually remain equilateral. The Swedish astronomer Charlier has put forth the conjecture that this unusual case is here really present. Poincaré at Paris has, in fact, proved that the triangle need not be so precisely equilateral, but that then relatively small determinate variations ("librations") from the equi-

lateral condition would have to enter. It would be wonderful if this should here be realized. The Trojan heroes would then manifest a harmony of the spheres which had never before taken place. We believe, indeed, that this beautiful dream—hitherto known only as a mathematical castle in the air—will not be completely realized, for the reason that the orbits of Achilles, Patroclus, Hector, and Jupiter have somewhat different eccentricities, and do not move exactly in the same plane. The disturbances, which Saturn and other planets exercise, would (one may certainly say without hesitation) be overcome by the libration.

However, the approximate exhibition of harmony promises an attractive display; and though it may cease at some later date, Achilles, Patroclus, and Hector may get into the immediate neighborhood of Jupiter and remain there for a long time. Their orbits would then be considerably transformed through his influence.

In conclusion, it is to be mentioned that Metcalf at Taunton, Mass., has brought the technique of observation to a higher degree through the fact that he has had his photographic telescope follow the mean motion of the planets. In this way the planets are shown in the shape of points and considerably brighter, the stars in the shape of faint strokes. Thus he has found in 1905 two, and in 1906 twelve new planets, and his improved method will probably soon receive general introduction.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Deutsche Revue.

KOUMISS.

THIS liquid, which resembles kefir and which is also called *vinum lactis* or *lac fermentatum*, plays a very prominent part in the life of the people of Siberia and Russia, for their livelihood is furnished almost exclusively by the horse; meat for food and milk as drink, etc. For the production of koumiss serves mainly the milk of mares, less frequently that of camels or asses. In consequence of being in spirituous fermentation, koumiss froths; in odor and taste it resembles buttermilk or slightly sour whey, and it contains casein in form of a fine suspended curd. Good koumiss is similar in taste to kefir, but less fine than the latter. In Russia sick people, especially those affected with tuberculosis, are sent for the summer for the purpose of a koumiss-cure to some Cosack village in the steppe. A few hours' distance from St. Petersburg there exists even a sanitarium where mares are kept and very thoroughly cared for for the sake of obtaining koumiss. Koumiss is made by placing old or sun-dried koumiss deposit in a vessel and adding some freshly secured mare's milk to it. This is then stirred for 15 minutes and allowed to stand over night. On the next day freshly milked mare's milk is added anew and well stirred from time to time until evening. In this way toward evening a weak koumiss is obtained. The fresh milk is, in this process, at once violently beaten by means of a perforated board. Then to 10 parts of milk one part of ready koumiss is added and allowed to stand, with constant stirring, for from two to three hours. After between two and three hours the liquid is filled into bottles and taken to a cool place. After from three to seven days violently frothing fermentation sets in with formation of an agreeable prickling, sweet-sour taste accompanied by an after-taste of sweet almonds; the color is milk white, the odor is sour and reminds one of the specific odor of the horse. The wholly fermented product forms the real koumiss which contains more alcohol, carbonic acid, and lactic acid than kefir. Some nomadic tribes prepare out of koumiss by means of distilling a sort of milk cordial, the so-called araca, which, however, on account of its high contents of volatile fatty acids, has anything but a pleasant taste. Better is the arsa which is obtained by rectification of araca. We distinguish three kinds of koumiss: fresh, one day old; older or medium strong, three to five days old; and five to seven day old or strong koumiss. In Germany, Austria, and Switzerland attempts have been made to produce koumiss also from the milk of cows; these were successful, but the koumiss prepared in this way has not been disseminated any further, for which reason it is to be supposed that koumiss, in spite of its hard and crude taste, possesses qualities which cannot be imitated by the milk of cows.

In the case of koumiss cures two or three glasses are taken daily, later on four bottles per day, and the patient ends by living almost entirely on koumiss. At first a slight degree of intoxication shows itself, then relaxation, weariness, and inclination to sleep; the latter remains throughout the entire cure, and in the case of using it from four to six weeks a considerable improvement of the nutritive condition takes place.

In the formation of koumiss, two fungi are said to be active, a lactic acid bacterium and a yeast. Vogeler found in koumiss *Torula cerevisia* and *Penicillium glaucum*. Schlipin found in koumiss a saccharomyces fungus, *bacillus acidilactici*, and the koumiss fungus, an independent organism which has so far been found only in koumiss. It is a true, but not a

strict, aerobic; it may, under circumstances, develop also in the atmosphere and grows better on acid than on alkaline nourishing substrata. Its optimum is at a temperature of between 20 to 30 deg. At 56 deg. C. it is killed after half an hour. It forms no sporules, multiplies by means of division, possesses independent movability and power of peptonization; moreover, it is capable of splitting sugar into alcohol and lactic acid. It is the principal fermenting fungus of koumiss, but begins its activity only then when the life conditions necessary have been prepared for it by *bacillus acidilactici*, the common lactic acid bacterium of milk and the saccharomyces. Its effect, therefore, comes only into consideration in the case of symbiosis with *bacillus acidilactici* and saccharomyces.

According to Vieth one and eight day old koumiss had the following chemical composition:

One-day-old.—Water, 90.14 per cent; alcohol, 1.69 per cent; lactic acid, 0.64 per cent; lactose, 4.34 per cent; total albuminoids, 2.20 per cent; casein, 1.15 per cent; albumose, 0.30 per cent; lactoproteine plus peptone, 0.75 per cent.

Eight-day-old.—Water, 91.02 per cent; alcohol, 2.14 per cent; lactic acid, 1.10 per cent; lactose, 2.30 per cent; total albuminoids, 2.16 per cent; casein, 1.18 per cent; albumose, 0.26 per cent; lactoproteine plus peptone, 0.72 per cent.

Many curative qualities are ascribed to koumiss, and since tuberculosis is absent in the Russian and Siberian steppes where it is being taken, it is, consequently, often successfully applied against this disease, and there have also been erected sanatoriums for tuberculosis in the territory of the Kirghises. It is an excellent food, on account of its contents of peptone, lactic acid, and alcohol, very easily digestible and promotes digestion; in the case of stomach troubles, scrofula, chlorosis, and anæmia it is being used with great success.

Lastly, mention should be made of the "mazun" of the Armenians from the milk of the bison or goat, but is also prepared from the milk of cows, and possesses a pleasant acid taste similar to that of kefir. It serves as acidifying material in the case of churning wherewith the butter assumes a pleasant aroma. Moreover, it serves as a beverage, and also for the production of various milk foods. The preparation is carried on in a way similar to that of kefir and koumiss, the lactic acid and alcohol fermentation probably takes place here also in a symbiotic manner. Nine kinds of yeasts are found, in addition to these also an anomalous yeast and the mazun-yeast, finally a micrococcus which hydrolyzes lactose and cane-sugar. The yeasts cause the peculiar aromatic mazun-odor. The "leben raib" of the Egyptians, a sweet-sour refreshing beverage of pleasant taste and peculiar aroma, is also fermented milk resembling kefir, still as contrasted to kefir it is curdled in flakes. In Egypt it is prepared from the milk of bisons, cows, or goats by mixing fresh milk with old "leben raib."

From leben raib five organisms have been isolated: a streptococcus growing in long chains, another streptococcus and a small bacillus, then a mycoderma-yeast, the latter having probably particular influence upon the peculiar taste of leben raib. The "yaourte" of the Greeks and Turks is very similar in taste to leben raib; it is, however, very questionable as to whether it is identical with leben raib, for it is said to contain different kinds of organisms.—From Pure Products.

ANALYSIS OF CONDENSED MILK.

ANALYSES of five samples of machine-skimmed condensed milk show that fat may vary from 0.30 to 1.26 per cent; casein, 9.05 to 11.10 per cent; sugar, 62.77 to 65.94 per cent; ash, 2.26 to 2.48 per cent; and water, 20.26 to 24.66 per cent. Boric acid is invariably found, being present in the proportion of 0.25 to 0.43 per cent. Other preservatives, such as formalin and salicylic acid, have not been found, nor was starch or viscogen. In three samples of full-cream condensed milk examined, the fat ranged from 8.20 to 11.13 per cent; casein, 8.37 to 10.95 per cent; sugar, 58.21 to 65.46 per cent; ash, 2.00 to 2.84 per cent; water, 13.04 to 18.70 per cent. Boric acid was present in two samples, 0.10 and 0.17 per cent respectively, while in the third none was found. A full-cream unsweetened condensed milk was found to contain fat, 10.13 per cent; casein, 10.86 per cent; sugar, 9.55 per cent; ash, 1.74 per cent; water, 67.72 per cent; boric acid, none.—F. J. Lloyd, Chemical News.

TEA FLOWERS.

THE buds of the tea plants, collected a few days before they expand, and dried, yield an infusion of very pleasant taste and agreeable odor; they contain about 2.1 per cent of caffeine, 2.65 per cent of ash, and 10 per cent of moisture. The sepals bear on their upper surface numerous one-celled hairs directed toward the apex, and exhibit in the mesophyll a wide layer of sclerenchymatous cells, varying greatly in size and shape, but similar to those found in the leaf. These characters allow of the identification of the buds.—E. Perrot and A. Goris, Bull. des Sci. Pharm.