process of organic decay becomes less active, a greater part of the vegetal and animal matter remains undecomposed, and its carbon is thereby locked up, and hence the loss of carbon dioxide through the organic cycle is increased. The impoverishment of the atmosphere is thus hastened and the epoch of cold is precipitated.

With the spread of glaciation the main crystalline areas, whose alteration is the chief source of depletion, becomes covered and frozen, and the abstraction of carbon dioxide by rock alteration is checked. The supply continuing the same, by hypothesis, re-enrichment begins, and when it has sufficiently advanced warmth returns. With returning warmth, the ocean gives up its carbon dioxide more freely, the accumulated organic products decay and add their contribution of carbonic acid, and the re-enrichment is accelerated and interglacial mildness hastened.

With the re-exposure of the crystalline areas, alteration of the rocks is renewed and depletion re-established and a new cycle inaugurated. And so the process is presumed to continue until a change in the general topographic conditions determines a cessation."

These results lead us to hope that on the ground common to geology and astronomy, as has been the case with chemistry and physics, many discoveries may be made which shall shed a new light on both.

STELLAR BANDS IN THE ZODIAC FROM GEMINI TO SCORPIO.

A. E. DOUGLASS.

For Popular Astronomy.

Various observers interested in the study of the zodiacal light, among whom may be mentioned Professors Simon Newcomb and Arthur Searle, have urged the especial study of stellar light in the zodiac, so that due allowance may be given it in determining contours of the zodiacal band and the Gegenschein. Observations of that class were made by the writer while in South America upon faint branches or large areas of the Milky Way, forty-five degrees or more from the galactic equator, bringing the Magellanic clouds within its reach. The accompanying map represents a more recent attempt to delineate such bands or areas of light in the portions of the zodiac between Gemini and Scorpio.

The drawings were made in March, April and May, 1895. Pro-

fessor Searle's method of observation was used, consisting in contours of equal brightness drawn upon tracing cloth placed over suitable star maps. Heis's Zodiacal Atlas has been found very convenient for this purpose. Twenty-one drawings on sixteen different nights were made, and of these the work on April 16 and 17 is the most complete since on each of those dates some hours were especially devoted to it. The longitudes in which bands were drawn in the various observations, are as follows:

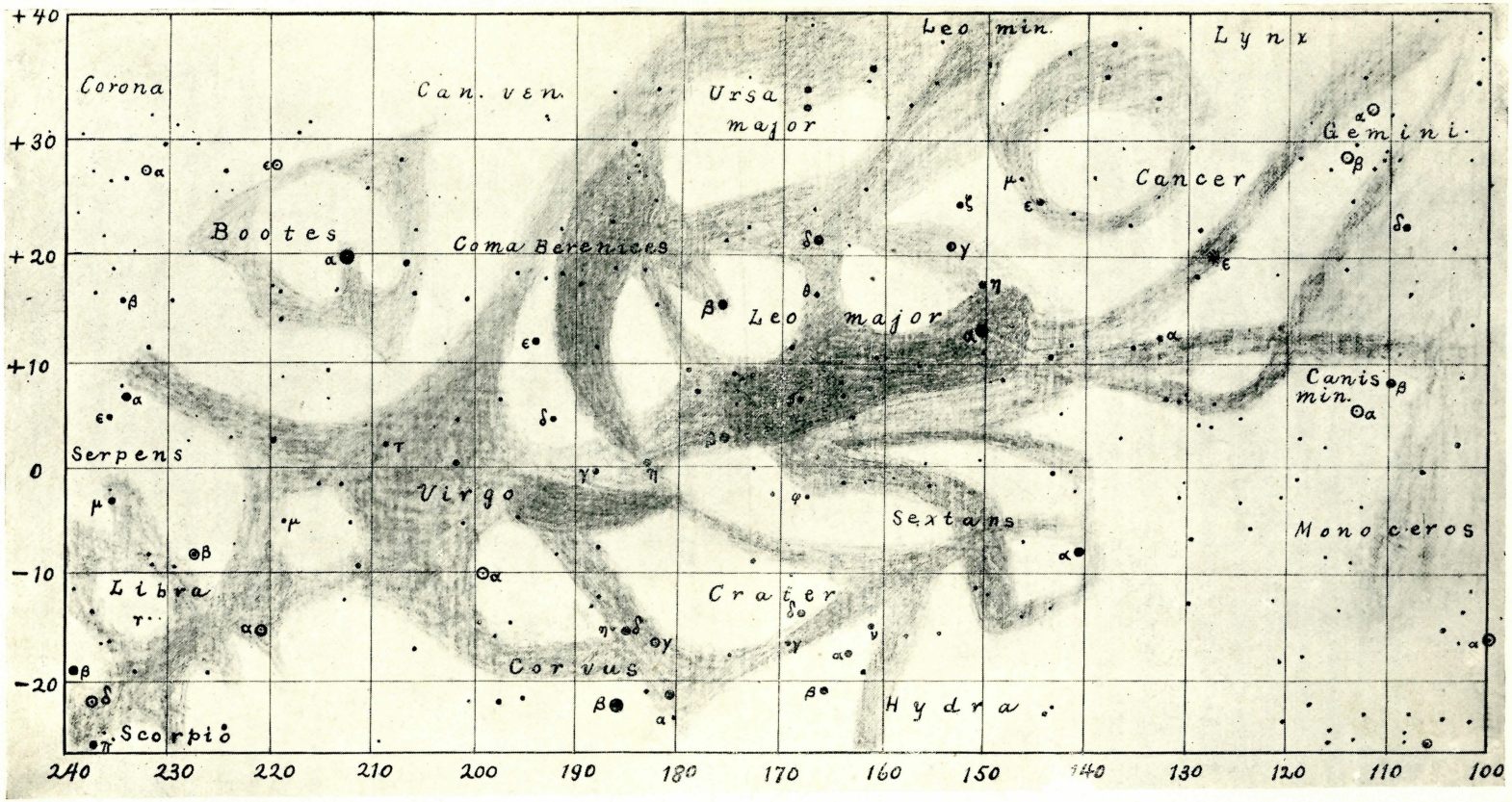
STELLAR BANDS OBSERVED IN 1895.

Date	Observation.	Longitudes. ° °	Date.	Observation.	Longitudes. ° °
March 24		180-200	April 17	I	170-220
27		160-200	17	II	110-210
30		160-200	17	III	110-240
30	I	180-200	18		150-210
31	II	180-210	19		180-220
April 1		180-200	20		180-200
14		150-200	22		100-180
15		140-220	26		210-230
16	I	90-180	27		210-230
16	III	140-200	May 24		220-240
16	IV	110-220			

All were made at Flagstaff save the final observation, in the City of Mexico. In anticipation of the present publication, independent drawings have been made here within the last few days, which are entirely concordant with these observations in 1895 in nearly every detail. The only correction of importance occurs in the region between the "Sickle" of Leo and the Milky Way, which should be largely filled with light, forming a border to the main stream of the Milky Way. This border extends over a part of the "Great Dipper."

As these bands are near the limit of vision they are exceedingly faint, and of course most reliance is to be placed upon those which show most conspicuously in the diagram; in the fainter portions it is likely that there are some small errors. Their average brightness is about that of the fainter parts of the zodiacal band when observed under favorable conditions. The brightest portion is the north-and-south branch in right ascension 190°. A more nearly circular area in right ascension 165° to 175° is almost as bright and is very closely the same as the average brightness of the Gegenschein. It has occasionaly been mistaken for it and observations on the Gegenschein while in that region are of little value. A small mass of light in right ascension 194° to 196° has also caused an erroneous position to be assigned to the Gegenschein.

An attempt was made to get rid of the effect of the zodiacal



STELLAR BANDS IN THE ZODIAC FROM GEMINI TO SCORPIO.

(See Page 511, No. 50, For Matter Descriptive of Cut.)

Apr. '98

POPULAR ASTRONOMY No. 52.

A. E. Douglass, Flagstaff, Arizona.

band in this chart but the long continuous band from Praesepe to Scorpio may partly be due to lack of success in this respect. It might be expected that the mere presence of bright stars would interfere with this work, and in some cases cause the appearance of a fictitious band, but in these observations there is no marked connection between bright stars and bands and therefore probably all of these are due to an extended area of fainter light and may legitimately be called branches of the Milky Way. In any case they are illuminations in the sky which may affect observations on the Gegenschein and zodiacal light.

For reproduction a combination drawing was made on tracing cloth and placed upon the proper map in Heis' atlas (epoch 1855) and a negative made through this.

Since reading proof of all that precedes, I have been fortunate in finding that Professor A. Searle, in 1885, described a band of light passing from Praesepe to β Virginis and thence northward. The western part of this be found attributale to Durchmusterung stars but the eastern portion, particularly the mass of light near right ascension 170°, could not be explained in this way. He suggests diffused nebulosity in that part of the sky.

LOWELL OBSERVATORY, Flagstaff, Arizona.

January 1, 1898.

ON SOME MODERN ATTEMPTS TO REPLACE NEWTON'S LAW OF ATTRACTION BY OTHER LAWS.

KURT LAVES.

FOR POPULAR ASTRONOMY.

Certain phenomena in the motions of some of our planets have led astronomers to question the correctness of Newton's law of gravitation as a general law of nature. It is the purpose of this paper. first to point out those phenomena which cannot be explained from Newton's law, and second to give a short outline of the nature of those laws which have been proposed to replace that of Newton's.

After Laplace and the great contemporary astronomers had accomplished the task of developing the theories of the planets' orbits, LeVerrier undertook the immense work of constructing tables for the great planets based upon all the observations available up to the middle of our century. These tables form the main body of the "Annales de l'Observatoire impérial de Paris" that famous standard work of astronomy. It is known that six quan-

tities—the so-called elements—characterize the motion of a planet about the Sun. If only one planet and the Sun existed these elements would be constant. But since the solar system is made up of a number of planets the effect is that on account of mutual attractions these elements must be made to change with the time in order to represent the disturbed motion of each planet. In the analytical expressions for the elements there occur terms which are of the nature: a constant multiplied by the time t. These terms are called secular terms since they become very sensible when we assign to t values equal or larger than 100 years. To give an example, we choose the orbit of Mercury. One of the elements is the longitude of the perihelion which we will designate with Π. This would be a constant for all time if no planet existed besides Mercury, but as this is not so Π is made to vary with t, so that—always considering but secular terms—it will be increased according to the theory in one century by 527″. This value is calculated from LeVerrier's tables. If we now derive the values of Π for two epochs which are one hundred years distant from each other from *actual observations* we find that the two values differ from each other not by 527″ but by about 568″. This difference of 41″ between theory and observation cannot be explained in any way when we start from Newton's law of general attraction. Le Verrier's attempt to explain it from the perturbing action of a group of intra-mercurial planetoids cannot be maintained since the most systematic and persistent observations made for the purpose of discovering such planetoids have shown no evidence of them. Professor Simon Newcomb has corroborated Le Verrier's work on Mercury by employing the large body of the modern observations since 1846; he shows that the secular acceleration of Π of Mercury which Le Verrier had determined to be 38″ should be increased by 3″ [see Professor Newcomb's paper: The elements of the four inner Planets and the fundamental Constants of Astronomy, Washington 1895, and chapter 28 and 29 of the fourth volume of F. Tisserand's *Mécanique Céleste*] Professor Newcomb proves that the acceleration in question cannot be accounted for by the assumption of a flattening of the body of the Sun since this would not produce a larger effect than 1″.2 in one century.

The example of Mercury was chosen purposely since it represents the most prominent discrepancy between observation and theory (Newton's law). The other differences of the same nature which have been brought to light are those in the longitude of the perihelion of Mars, the longitude of the nodes of Venus