

## NOTES FROM PACIFIC COAST OBSERVATORIES.

## NOTE ON THE PLANETARY NEBULÆ.

The planetary nebulæ form a very interesting subdivision of the great class of nebular objects. By their small size, clear-cut and sharply-defined character they are differentiated from the great diffuse nebulosities on the one hand, and from the great class of spirals on the other hand both by their distribution in the sky and by their spectrum. Relatively to the entire number of the stars they are rare objects; less than one hundred and fifty are known, and they may possibly be a sporadic case of stellar evolution. The complex and puzzling internal motions which are now being discovered in these objects by means of the spectrograph have opened up a new and highly interesting field.

Their small size, and the great contrasts in the intensity of the inner and outer portions of many of these objects make it almost impossible to illustrate their form by direct photographic enlargements. The most satisfactory method has proved to be to make composite drawings from a series of exposures of each object, ranging from a few seconds to an hour or more. Such reproductions of all the planetary nebulæ accessible from the northern hemisphere have been made, and will shortly be published by the Lick Observatory; six typical objects of the class are shown on the page facing this note, several of which are referred to in the notes by Messrs. Campbell and Moore, published elsewhere in this number.

A brief description of these objects follows:

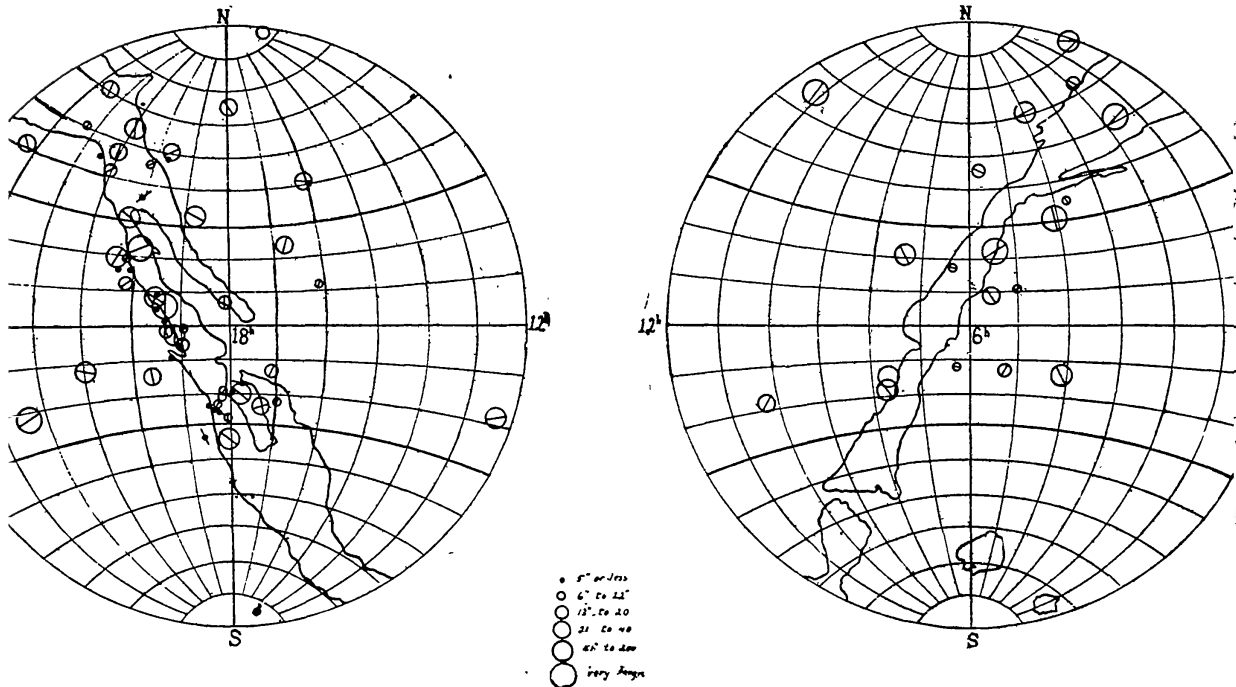
N. G. C. I 351: This object is a minute oval disk about 8" by 6" in position angle about  $10^\circ$ ; an elongated brighter patch in the center can be seen, and a faint nucleus. Quite bright.

Jonckheere 320: A central star surrounded by a rather bright oval of nebular matter, 7".7 by 4".8 in short exposures. Long exposures show a faint ring formation 22" long in position angle  $168^\circ$ . The brighter central oval shows a very indistinct ansa or edgewise ring effect.

N. G. C. 6058: This is an irregular oval, 25" by 20", very

much fainter along its major axis in position angle  $77^\circ$ , with a fairly bright stellar nucleus. This form, somewhat resembling the Dumb-Bell Nebula, is fairly typical.

N. G. C. 7026: This is a very irregular object, unique among planetary forms thus far observed. The shortest exposures show two elongated, slightly curved lobes  $5''$  long, symmetrically placed on each side of a faint central star, and  $6''$  apart from center to center. In longer exposures the central parts take the form of an H, and irregular wisps are seen at each end, making the total length about  $25''$ .



DISTRIBUTION OF THE PLANETARY NEBULÆ.

N. G. C. 40: A beautiful object; strong stellar nucleus; the nebula resembles a truncated spherical shell, from the ends of which extend much fainter wisps. Its total length along the major axis in position angle  $14^\circ$  is about  $60''$ .

N. G. C. 7009: One of the brightest and most interesting objects in the planetary class, and evidently of a very complicated structure. The slightly oval disk is about  $30''$  by  $26''$ , while the almost stellar condensations at the ends of the ansæ are  $48''$  apart in position angle  $79^\circ$ .

I have plotted, as shown in the cut above, all the planetary nebulae to about  $33^\circ$  south declination. The black dots repre-

sent the smallest objects, while the small circles indicate by their increasing size the various sizes of planetary nebulae. A line indicates on each circle or dot the position of the major axis of the planetary; where no line is drawn the object is round. It will be seen that the lines indicating the positions of the major axes are random in their arrangement, and that there is no apparent tendency for the major axes to be arranged parallel to any one given plane, *e. g.*, that of the Milky Way.

Considering the arrangement of the planetaries by apparent size, a very interesting feature is at once noted. Like most celestial objects (excepting, of course, the spiral nebulae), the planetaries are emphatically a galactic phenomenon, showing a strong tendency to group themselves in or near to the Milky Way. Now practically all the smaller objects of the class are in or very close to the Milky Way. On the other hand, the larger ones, and the giants of the class, are fairly well distributed over the sky. This is just the distribution which would be expected if the larger planetaries were really, as indicated by their apparent size, the nearer to us. It would then seem that the larger planetaries are very favorable objects for inclusion in parallax programs; the evidence, both of apparent size and distribution, points to the fact that they are relatively near objects, and the great majority of them have central stars on which measures could easily be made.

H. D. CURTIS.

#### FOUR NEBULÆ WITH BRIGHT-LINE SPECTRA.

As far as we know, nothing has hitherto been published concerning the spectra of the four bright planetary nebulae listed below. We have observed all of them for radial velocity by means of 3-prism spectrographs, and have found their spectra to be of the usual bright-line type. The continuous spectrum of the fourth object, N. G. C. 6058, is unusually strong for a planetary nebula, and the spectrum should be studied further.

N. G. C. Index 351	$\alpha$ (1900)	3 <sup>h</sup> 41 <sup>m</sup> .1	$\delta$ (1900)	+34° 45'
Jonckheere 320		5 0 .0		+10 34
Jonckheere 900		6 20 .1		+17 51
N. G. C. 6058		16 1 .0		+40 57

N. G. C. Index 351 was discovered and announced by Barnard in 1890. Jonckheere 320 and 900 were discovered and announced by Jonckheere in 1916 and 1912, respectively.

N. G. C. 6058 was photographed by Curtis with the Crossley Reflector, and from the resemblance of its form to that of planetary nebulae he predicted that we would find bright lines in its spectrum.

W. W. CAMPBELL,  
J. H. MOORE.

#### SPECTROGRAPHIC OBSERVATIONS OF ROTATION IN THE PLANETARY NEBULA N. G. C. 7026.

We have recently obtained spectrographic observations of the planetary nebula N. G. C. 7026 which are of special interest in that they indicate for this object a high angular velocity of rotation.

The form of this nebula is well shown in the drawing of the object made by Dr. Curtis, a reproduction of which accompanies his note in the present number of these PUBLICATIONS.

With the slit of the spectrograph placed parallel to the major axis of the nebula and between the two lobes, the bright portion of the spectral lines is found to be inclined  $4^{\circ}.3$  to the zero direction, as given by the comparison lines. This inclination, interpreted as a Doppler-Fizeau effect, is in the sense that a point on the major axis 4 seconds of arc south of the center is receding, with reference to a similar point north of the center, with a relative velocity of about  $42\text{km/sec}$ .

Spectrograms taken with the slit in the same position angle as the first one described, but set respectively along the eastern and western lobes, show the spectrum lines inclined in the same direction as before, but a little smaller in amount (about  $4^{\circ}$ ).

When the slit was placed along the short axis (*i. e.*, across the two lobes and the central nucleus), the spectrum lines appeared somewhat broad and hazy, but have no appreciable inclination.

Considering the general form of the outline of this nebula,