4. M. W. Krieger, *Geophys.* **9**, 447, 1944.
5. *Science* **103**, 280, 1946.
6. *Anal. Chem.* **20**, 396, 1948.
7. Arthur Adel, *A. J.* **55**, 69, 1950.
8. Progress Report on High Altitude Infra-red Transmission of the Atmosphere, Johns Hopkins O.N.R. Contract N5ori-166, Task Order V, Jan. 1949.
9. R. L. Slobod and M. E. Krogh, *J. Amer. Chem. Soc.* **72**, 1175, 1950.

*Arizona State College,
Flagstaff, Ariz.*

Alden, Harold L. Astrometric orbits of Ci 20, 545 and 591.

The star Ci 20, 545 shows periodicity in the residuals in both right ascension and declination of the order of 460 days. Inclusion of orbital terms in the solution reduces the sum of the squares of the residuals considerably, yielding a semi-major axis of $0''.038 \pm 0''.008$, an inclination of 94° , and a node at 135° .

Forty-five plates taken in the years 1936–1950 with the McCormick 26-inch refractor of the star Wolf 358 (Ci 20, 591) fail to show orbital motion as found by observers at the Van Vleck Observatory in 1928–1933. Their periodicity was apparently confirmed, but with smaller amplitude, at the Yale Southern Station from 3 plates in 1930 and 24 in 1939–1943. Since Dr. Joy lists the star among those having variable radial velocity, the absence of observable orbital motion requires explanation.

*Leander McCormick Observatory,
University of Virginia,
Charlottesville, Va.*

Aller, Lawrence H. Photometry of emission nebulosities in Messier 33.

The spiral nebula Messier 33 contains a large number of emission nebulosities comparable with Orion, Messier 8, and Trifid nebulae in our own galactic system. Most of these objects were discovered with the Tonanzintla Schmidt by G. Haro who kindly supplied us with finding charts in advance of publication. Objective prism spectrograms have been obtained upon 103a-E emulsions through a plexi-glass filter with the Curtis Schmidt telescope. Photometric calibration was provided with a tube sensitometer. Microphotometer tracings were made of 150 separate emission patches and suitable comparison stars in Selected Area 45. Magnitudes and spectral classes of the latter stars are given in the *Bergedorfer Spektral Durchmusterung* and permit the determination of the brightnesses of the nebulosities on a true intensity scale. For objects with perceptable areas, surface brightnesses in

$H\alpha$ emission may be determined. On the assumption that the forbidden $[N_{II}]$ lines are weak compared with $H\alpha$ and that the Balmer decrement is the same as for similar galactic nebulae, electron densities have been derived for NGC 588, 595, 604, and a number of other objects. The values fall in the range 10 to 40 electrons/cm³, suggesting that the objects are considerably denser than the faint extended zones of ionized hydrogen discussed by Struve, Henyey, Strömgren, and Elvey, but much less dense than typical planetary nebulae, or perhaps the brighter parts of the Orion nebula.

*The Observatory,
University of Michigan,
Ann Arbor, Mich.*

Baker, James G. Apochromatic correction for refractors.

Although large refracting telescopes perform almost ideally, in so far as resolving power is concerned, the color curve or secondary spectrum of such telescopes has proved a handicap for photographic, spectrographic, and photoelectric attachments. Photographically, one must use prolonged exposure times to make up for inefficiency brought about by poorly focused colors in a star image. Spectrographically, one loses a great percentage of light at the slit jaws where again poorly focused starlight fails to enter. Photoelectrically, one finds it difficult to exclude skylight sufficiently well or to work on close objects separately.

The Medial telescope developed by Schupmann has a greater range of application than has generally been recognized over the years, and a form of this type of telescope is being used for one of the smaller Harvard coronagraphic instruments. However, the design and construction of a Medial telescope is a new undertaking.

The author has found it possible to extend the Medial principle to existing large refractors. The "refractor-corrector" consists of a field-lens and Mangin lens-mirror attachment beyond the focal plane. The negative lens portion of the Mangin may take on a number of forms, but basically the lens system is a strong negative achromat. The concave mirror portion of the Mangin returns the light to a real focus at unchanged scale, where the usual photoelectric and spectrographic instruments may be used. Different mechanical arrangements are possible according to one's convenience.

Calculations show that the correction of sec-

ondary spectrum in the second focal plane is nearly complete, and at $f/15$ within the Rayleigh limit over the spectral range from 4000 to 8500 angstroms. The corrector may be used, then, to bring about color-free star images for even the largest refractors.

*Harvard College Observatory,
Cambridge, Mass.*

Bok, Bart J., and Priscilla F. Bok. A photoelectric sequence of magnitudes and colors for Selected Area 141.

Selected Area 141 at R.A. 1^h , Dec. -30° , is located close to the south galactic pole and not far from the Sculptor cluster. The Linnell-King photoelectric photometer of the Boyden Station has been used for the establishment of a standard sequence of magnitudes and colors for this Area. "Blue" and "yellow" magnitudes in a well-defined color system have been obtained for a skeleton sequence of twenty stars in the magnitude range 9 to 15.5. The internal agreement of our observations indicates that the probable error of a final blue or yellow magnitude of a sequence star of magnitude 14 or brighter is of the order of ± 0.01 mag., and that the corresponding probable error may be as high as ± 0.03 at 15.5 mag.

Observations on six nights relate the zero point of our magnitudes to that of the Whitford-Johnson magnitudes for Selected Area 68 with an error not exceeding ± 0.02 mag.

*Boyden Station,
Harvard College Observatory,
Bloemfontein, South Africa.*

Brouwer, D. Comparison of numerical integration of the motions of Uranus and Neptune with Newcomb's tables.

Positions of Uranus and Neptune were computed from Hill's tables with an interval of 500 days from 1776 to 1950 and for Uranus with an interval of 2000 days backward to 1653 and forward to 2060.

In the case of Neptune, corrections to the elliptic elements combined with the effect of Pluto, included in the integration but not included in Newcomb's tables, account satisfactorily for the difference between numerical integration and tables. Comparison with observations confirms the mass used for Pluto in the numerical integration ($m_P/m_\odot = 1/360,000$).

Uranus shows systematic differences between integration and tables, similar to those found for Saturn. They indicate imperfections in New-

comb's theory. The observations of Uranus since its optical discovery do not yield a significant determination of the mass of Pluto. A new discussion of the pre-discovery observations of Uranus and their direct comparison with the numerical integration is in progress. With the addition of this material a new determination of Pluto's mass from the motion of Uranus will be made.

This investigation was part of research carried out with support from the Office of Naval Research.

*Yale Observatory,
New Haven, Conn.*

Cillié, G. G., and B. J. Bok. The photoelectric light curve of TW Ceti.

An accurate period has been determined for the eclipsing variable TW Ceti and light curves derived in blue and in yellow light with the Boyden station photoelectric photometer attached to the Rockefeller reflector. Two equal maxima and two unequal minima occur in the revised period $0^d.31685260$. The zero point of the elements published earlier by Zessewitsch refer to the secondary eclipse. The form of the light curve and the spectroscopic observations made by O. Struve show that TW Ceti is a normal W Ursae Majoris variable.

*Boyden Station,
Harvard College Observatory,
Bloemfontein, South Africa.*

Clemence, G. M. Comparison of numerical integration of the motion of Saturn with Hill's tables.

The integration by the Selective Sequence Electronic Calculator of the motion of Saturn 1653-2060 has been compared with positions of Saturn taken from Hill's tables, at intervals of 1920 days. The rectangular equatorial coordinates referred to the mean equinox and equator 1950.0, given by the integration, were transformed to heliocentric longitude, latitude, and radius vector, referred to the mean equinox and ecliptic of date.

Errors are indicated in all three of the coordinates extracted from the tables. The salient features of the curve showing the error in the longitude are (1) a term with period the same as that of Saturn's revolution, with a coefficient that increases continuously with the time before and after the epoch of the tables, 1850, reaching $2''$ in 200 years, which is attributed to an error in Hill's secular perturbations, and (2) a term