of gf value with increasing excitation potential seems to be absent from our measurements. The implications of these results to solar and stellar abundances are discussed.

Masses of the Dwarf M Stars in the Mu Herculis System. JAMES F. WANNER, *Sproul Observatory*.—From 80 plates taken between 1938 and 1965 at Sproul Observatory, the parallax of Mu Her A and the unresolved binary companion Mu Her BC has been measured. With earlier results from Allegheny and Leander McCormick Observatories, these measurements yield an absolute parallax of $0''.13 \pm 0.01$ for the system. From the same plates, the semi-axis major of the photocentric orbit of Mu Her BC is found to be $0''.14 \pm 0.03$. Adoption of a magnitude difference for BC of $0^m.46$ (Eggen, O. J., *Astron. J.* **61**, 372, 1956) results in a mass ratio of 0.50 ± 0.04 . A micrometric orbit by Couteau (*Bull. Astron.* **23**, 127, 1960) with $a = 1''.36$ and $P = 43^y.2$ permits the deduction of individual masses, $M_B = M_C = 0.31 \pm 0.10 M_\odot$. Both stars lie within $0^m.5$ of the mass-luminosity relation. BD + 27°2891, which lies in the same field and was measured with Mu Her, seems to have a large parallax and/or show orbital motion and deserves further study.

Observations on the Relative Energy Spectra of Different Cosmic Ray Nuclei that may Provide a Test on Whether these Nuclei have an Origin at a Single Epoch in Time. WILLIAM R. WEBBER, *University of Minnesota*.—During the recent period of minimum solar modulation of cosmic rays we have made a systematic study of the relative energy spectra of protons, helium, and heavier nuclei with charges ranging from 3 to 26. These measurements have been made with a double scintillation-Čerenkov counter telescope at seven different geomagnetic latitudes and have enabled the energy spectra to be obtained from $\simeq$ MeV/nucleon to over 5 BeV/nucleon.

From these spectra, which are based on the measurement of the energy and charge of some 5000 nuclei with $Z \geq 3$, we conclude; (1) The maximum in the differential spectrum is shifted to higher energies and depressed for successively increasing charges; (2) below the maximum the intensities of successively increasing charges are enhanced. This behavior appears to result from propagational effects outside of the solar system. The data can be explained by assuming that, above $\simeq 1$ BeV/nucleon, all nuclei have passed through a unique 4 g/cm^2 of hydrogen subsequent to their acceleration. At lower energies the amount of hydrogen

traversed appears to be simply proportional to the particles velocity.

Such a path length variation would seem to support the hypothesis that the heavy nuclei are accelerated at a single epoch in time and their subsequent motion is such that $\bar{\rho}t = \text{const}$. Measurements on the Be/B ratio as a function of energy indicate that this time $\geq 5 \times 10^7$ yr. Models wherein cosmic rays are continuously created within the galaxy (e.g., supernova) require that an equilibrium be set up in which the "average" path length should be independent of velocity or $\simeq 1/P$, depending upon the confinement conditions. Our observations do not agree with this variation of path length with energy.

Spatiokinematic Structure of Planetary Nebulae.

DANIEL W. WEEDMAN, *Washburn Observatory*.—Models have been constructed for a number of planetary nebulae in an attempt to represent both the physical distribution of the emitting material and the kinematics of this material. The models are based on an analysis of the line profiles derived from high dispersion spectrograms of bright emission lines in the planetaries obtained with the 100-in. Hooker and 84-in. Kitt Peak telescopes.

The planetary nebulae studied include NGC 6210, 3242, 7662, 7009, 6826, 2392, 6572, and IC 418 and 3568. For each nebula a model is derived representing the spatial distribution of emitting material and the kinematics of this material. Correlations are made between the structure and kinematics, and conclusions are drawn concerning the past history of the nebula.

It is found in particular that ellipsoidal shells show a velocity of expansion which increases with distance from the central star, implying that the shell is now ellipsoidal because the original velocity of ejection varied with direction. Evidence is also presented to indicate that some planetaries consist of at least two independently ejected shells, the outer shell usually containing at least twice the mass of the inner. Kinematic temperatures are also derived by comparing the line profiles of forbidden oxygen and hydrogen to isolate the thermal broadening. The temperatures thus obtained range from 7000°K for NGC 7009 to 14 000°K for NGC 7662.

Of particular interest is NGC 7662. A detailed model shows the inner emitting shell to be quite thin, the thickness being about two-tenths of the radius. The gradient of expansion velocity through this shell can be accurately determined and its magnitude indicates that the observed line profiles can be explained without assuming the existence of turbulent motions within the shell.