Dynamical Models of Planetary Nebulae. S. SOFIA, *Goddard Institute for Space Studies*, AND J. H. HUNTER, *Yale Observatory*.—Dynamical models of the post-ejection stage of planetary nebulae have been built, for various initial conditions, taking detailed account of the most important heating and cooling processes.

In computing the photo-ionization heating by the ultraviolet quanta of the central star, information about the flux and evolution of the star is utilized. The optically thin condition is used throughout. In computing the nebular cooling, the ionic balance is calculated at every mesh point in space and time, using the hydrogenic approximation for the atomic absorption coefficients. Free-free and 40 forbidden line transitions were taken into account, making allowance for collisional de-excitation. The model nebulae are made up of 10 elements and ions up to $\chi = 200$ eV are considered.

The dynamical models were advanced in time using a numerical code written in Eulerian variables. The code is highly accurate, utilizing fifth-order backward time differences to advance the variables in a predictor-corrector algorithm. The number of space mesh points is also variable in order to conserve computer time.

While details of the results vary from model to model, the following general features are common to all of them:

(a) Starting with a shell of a constant temperature, say $10\,000^\circ\text{K}$, the expansion quickly cools the nebula much below the equilibrium condition given by the static model. Once the shell has expanded to a certain point, however, the photo-ionization heating dominates over expansion cooling and the temperature raises slowly towards the above-mentioned equilibrium value, which in general is reached when the nebula is too diluted to be seen.

(b) Irrespective of the initial velocity profile a shock wave always develops in the forward direction. For some initial conditions there is a shock wave moving back towards the star. While for physical and numerical considerations we avoided using such initial conditions for long computer runs, in all cases studied in this investigation no substantial amount of matter falls back on the star, at variance with previously published results.

Upon comparing the dynamical models with observations, it was found that a spherically symmetric nebular model is able to account for the observed radial dependence $\text{H}\beta$ emission. Thus, it is unnecessary to postulate the existence of torus-like structures.

Comparison of theoretical line profiles with observed line profiles were made at different evolutionary stages, and the agreement was good.

Theory of the Explosion in M82 II. ALAN B. SOLINGER, *The University of Michigan*.—A hydrodynamic blast-wave model provides a theoretical basis for understanding observed features of the explosion in M82. A. B. Solinger (*Astron. J.* **71**, 872, 1966) has pointed out that a self-similar Sedov solution predicts the flow observed, and the blast is a more suitable heating mechanism for excitation of the $\text{H}\alpha$ in the filaments than the synchrotron process. Evidence is presented here that the polarized continuum observed is due to Thomson scattering of light from a Seyfert-like nucleus—not synchrotron emission.

Analysis of the data (Elvius, A., *Bull. Lowell Obs.* **5**, 281, 1963; *IAU Symp. No. 29, Armenian SSSR*, 1966, to be published) shows that polarization increases and intensity decreases with increasing central distance. Models based on the similarity solution are quantitatively fitted to these data. The parameters are shock position, electron density, bremsstrahlung intensity, and luminosity of the nucleus. All parameters are evaluated within a factor of 4. The luminosity of the nucleus is 1.5×10^{43} erg/sec—about that of a typical Seyfert nucleus; the energy of the explosion, 4.5×10^{58} erg, released 7.5×10^5 yr ago; average shock radius, 1.9×10^3 pc; and the post-shock electron density, 8.5 cm^{-3} . This implies the existence of a circumgalactic density of about 2 cm^{-3} .

The expected bright Seyfert-like nucleus may be unobserved for either of two reasons: the large quantities of observed dust may obscure it, in which case it should be detectable in the infrared; or the nucleus may have ceased radiating as much as 300 yr ago. Because of the large light travel time, one would still observe the scattering.

We suggest that M82 is/was a Seyfert galaxy, seen edge-on. If similar explosions occur in other Seyfert galaxies, polarization due to electron scattering should also be observed in them.

Theoretical Models of Novae. WARREN M. SPARKS, *Indiana University* (present address: Goddard Space Flight Center).—The present investigation is a study of the effects of a sudden injection of internal energy into an envelope that is in radiative and hydrodynamic equilibrium. The time variation of the pressure, temperature, density, position and other physical quantities is determined at many fixed mass points. The emergent luminosity and the "velocity of the photosphere" are then known as functions of time. These quantities are compared with observations of novae. (The "velocity of the photosphere" is compared with the velocity of the absorption spectrum in a qualitative way, which is justifiable.)

It is found that there are two types of ejections