(10³¹). The predicted values of the yearly acceleration are $-''00010$ and $+''00123$ in right ascension and declination, respectively. The probable error, $\pm''00003$, of the predicted acceleration in declination could be reduced primarily by better knowledge of the radial velocity.

Barnard's star has been photographed with the Sproul 24-inch refractor, the parallax series of 24 plates taken in the years 1916–1919 being followed by a series covering the interval 1938–1961 and totaling 2316 plates. The measurements were combined into yearly means; after correcting for parallax, a least-squares solution yields an observed acceleration of $+''00012 \pm ''00005$ (R.A.) and $+''00051 \pm ''00002$ (Dec.).

The probable errors of unit weight are $\pm''099$ (R.A.) and $\pm''045$ (Dec.). There are, as yet not fully explained, systematic features which account for the abnormally high probable error in right ascension. The yearly mean positional values in declination appear to be free from any appreciable systematic effects, be they of observational or cosmic origin.

The proper motions of the reference stars on the background of 24 faint stars, were obtained from two pairs of plates with an interval of 44 years. The spurious accelerations $-2[\Delta D_{\mu_x}]$, $-2[\Delta D_{\mu_y}]$, caused by the large proper motion of Barnard's star and the proper motions of the three reference stars, amount to $+''00026 \pm ''00003$ and $-''00067 \pm ''00003$ (p.e.) in right ascension and declination, respectively. Correcting for this effect, the true perspective acceleration is found to be $-''00014 \pm ''00006$ (R.A.) and $+''00118 \pm ''00004$ (Dec.) in good agreement with the predicted value.

Are Clusters of Galaxies Stable? SIDNEY VAN DEN BERGH, *David Dunlap Observatory*.—All northern Shapley–Ames galaxies were examined for possible cluster membership on the prints of the Palomar Sky Survey. In assigning galaxies to clusters all available data on radial velocities, luminosity classifications, diameters, magnitudes and surface brightnesses were taken into account. The resulting frequency of cluster membership is shown below.

	Elliptical	Spiral + Irregular
Galaxies in relatively rich clusters	115 (56%)	258 (38%)
Galaxies in poor clusters	42 (20%)	97 (14%)
Isolated galaxies	50 (24%)	321 (48%)

The data in the table indicate that about half of all spiral and irregular galaxies are at present located in clusters. A significant fraction of all clusters containing spiral and irregular galaxies must therefore be stable over a time scale comparable to their age.

The fact that three-quarters of all elliptical galaxies are at present members of clusters implies that most clusters containing a strong population of ellipticals

must be stable over periods comparable to their ages, i.e., most clusters containing ellipticals which were ever created are still in existence at the present time.

Acceleration of Electrons near Solar Flares.

DONAT G. WENTZEL, *University of Michigan Observatory*.—Two efficient versions of Fermi acceleration by hydromagnetic shocks are presented. One version is based on the work by Parker (*Phys. Rev.* **109**, 1328, 1958) on acceleration between approaching shocks. It is shown that the mechanism is efficient even for moderate shock strengths. Efficient acceleration is also shown to occur ahead of a shock moving into stronger fields. As the particle is accelerated by the shock it is able to penetrate stronger fields, but the shock field also becomes stronger, so that the particle remains trapped even while it gains energy. Doubling of the energy by each passing shock is possible in plausible magnetic fields. Two conditions of acceleration are that the particle moves faster than the shock and that collisional energy losses are negligible.

For solar thermal electrons the conditions of acceleration hold only in and above the upper chromosphere in the high-energy tail of the velocity distribution. With $T_e = 3 \times 10^5$ °K, $n_e = 10^9$ cm⁻³, and an estimated shock frequency of 10 sec⁻¹, about 10⁻² of all electrons are accelerated. The thermal tail is replenished nearly as rapidly as it is depleted by shocks, and in about $\frac{1}{2}$ min the whole electron gas is heated to roughly 30 keV. Further acceleration is inefficient since the electron magnetic moment is then not constant. The electrons emit bremsstrahlung by collisions among themselves and the intensity, risetime, energy, and spectrum of the observed x rays can be adequately explained. Motion of the fast electrons downwards to $n_e = 8 \times 10^{10}$ cm⁻³ may heat the electron gas there to several 10⁶ °K and may explain some cm-wave radio bursts with apparently thermal spectra. The hot region is ejected into the corona, where it expands under its own forces.

Meteoritic Erosion in Space.

FRED L. WHIPPLE, *Harvard College Observatory*.—Photographic meteor studies and spallation products of cosmic rays in meteorites provide upper limits or evaluations of erosion rates for meteoroids in orbit. The rate increases by several orders of magnitude in the sequence: irons, stones, and photographic meteoroids. The sequence suggests that the erosion rate depends in some inverse fashion upon the strength or brittleness of the materials, a natural expectation if erosion is produced by crater-forming impacts with interplanetary dust. On this assumption and by applying a high-velocity impact theory, the author derives a mean space density for the dust at roughly 10⁻²¹ g cm⁻³.