particles of interplanetary material, we have taken advantage of the braking quality of the earth's atmosphere and have collected particles there. This method is more practical than any method of collecting particles in space, where the high velocities of particles normally cause them to be destroyed on impact with any collecting device.

Using high-altitude jet aircraft, we have obtained some 50 samples of high-altitude dust. Each sample consists of the dust filtered from a volume of usually about 10 cubic meters. Collections were made at various altitudes, ranging from 30 000 to 90 000 ft. The computed space densities of particles varies greatly, even at the same altitude and latitude. We calculate an average space density, for particles greater than $3\ \mu$ in mean dimension, of approximately 250 particles per cubic meter for the altitude range 40 000 to 50 000 ft. This value increases greatly for lower altitudes, and appears to decrease slowly for higher altitudes. We obtain a value of 150 for the mean space density in the range 60 000 to 90 000 ft. The bulk of these particles are found to be transparent or semitransparent, with only about 1% resembling meteoritic material in appearance. These few particles lead to an upper limit for the influx rate of meteoritic material of less than 10^6 tons per day. A few particles have been analyzed chemically.

The Diurnal Atmospheric Bulge and Its Effect on Satellite Motions. STANLEY P. WYATT, *University of Illinois Observatory*.—Several authors have derived expressions for the secular acceleration of a satellite moving through the high atmosphere and giving away momentum to the air. The simplest assumptions one can make are that the atmosphere is spherically symmetric, stationary, and of constant scale height. The resulting drag formula then permits one to use the observed accelerations to deduce the product of air density times the square root of scale height at the perigee level of the satellite.

Analyses by a number of authors have revealed primary facts concerning the structure of the outer atmosphere. First, the scale height of the atmosphere increases with height above ground throughout all strata traveled by satellites. Second, on the daytime hemisphere the atmospheric density correlates strikingly with solar activity. Third, at heights of 500 km and more the atmosphere bulges conspicuously toward the sun. In October of 1958, when Vanguard I was passing through perigee at local time 13 or 14 hr the air density at 650 km was some 10 times greater than from mid-1959 to

mid-1960 when its perigee passage occurred during the nighttime hours. At any geographic position this variation amounts to a diurnal rise and fall of the high atmosphere, with maximum expansion occurring an hour or two after noon.

Jacchia has used the accelerations of four satellites to construct a model of the atmosphere in the 200–600 km range, incorporating all three of these effects (Jacchia, L. G., *Smithsonian Astrophys. Obs. Spec. Rept.* No. 39, 1960). Because the atmosphere has neither spherical symmetry nor an exponential decrease of density, the present work is addressed to the derivation of a new and more complex drag formula relating perigee density and scale height to the observed acceleration of a satellite moving through a Jacchia-type atmosphere. The essential results are twofold. First, use of the earlier and simpler drag equation may yield atmospheric densities that are systematically incorrect by as much as 50 or 60%, the sign and amount of the error depending on the orbital elements and the orientation of the orbit relative to the bulge on any given date. Second, and provisionally, the new formula indicates that the diurnal bulge is even sharper than previously thought.

This work was partly done at the Smithsonian Astrophysical Observatory.

Stellar Kinematics and Spiral Arms. ANDREW T. YOUNG, *Harvard College Observatory*.—Monte Carlo calculations of the velocity distribution of young stars in the solar neighborhood have been made on the IBM 7090 computer of the Smithsonian Astrophysical Observatory, assuming that: (1) stars are formed only in spiral arms; (2) the velocity distribution of newly formed stars is isotropic and Gaussian in form, and its centroid coincides with the motion of the gas (which differs from the gravitational circular velocity); (3) the arm shares the physical motion of the gas.

It is found that if the gas velocity is that recently found by Kerr (an outward streaming of about 7 km/sec relative to the standard solar motion), and if the tilt in the arms is small (as indicated by the 21-cm observations), then the observed velocity distribution for relatively young stars can be completely accounted for. In particular, the vertex deviation and anomalous axial ratios of the velocity ellipsoid are quantitatively explained. Furthermore, the motion of the sun relative to the local circular velocity turns out to lie much closer to Vyssotsky's "basic solar motion" than to the "standard solar motion" of 20 km/sec.