The core source is presumably to be identified with the well-known jet extending from the nucleus of M87. In a separate observation, Bolton has found the radiation from the core to be $\gtrsim 3\%$ polarized at 958 Mc. At very much higher frequencies, the radiation from the core should dominate. However, existing measurements at about 8000 Mc require that the spectrum of the core becomes steeper above 1420 Mc.

Preliminary analysis of brightness distributions in 130 sources has shown that such a complex structure is quite common. Some sources contain a core plus a halo, while others display a double peaked structure resembling that of Cygnus A.

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Estimation of the Dispersion of Redshift for Field Galaxies.

JERZY NEYMAN AND ELIZABETH L. SCOTT, *Statistical Laboratory, University of California, Berkeley 4, California*.—It is assumed that the redshift Z of a field galaxy at distance D is a random variable with expectation HD , where H is the Hubble constant, and with variance $\sigma^2 = E(Z - HD)^2$ independent of distance. The problem treated is the estimation of σ^2 using the values of redshift Z and of apparent magnitude m of field galaxies in a catalogue, that is, subject to selection. The theory developed assumes (i) a catalogue of field galaxies resulting from an effort to include all galaxies observable with given instruments; (ii) the galaxies in the catalogue are reliably classified into morphological types fine enough to ensure that the ease of observing any two galaxies of the same type depends on their apparent magnitude only. Working in Euclidean space, it is found that among catalogue galaxies of a fixed type: (a) the regression of Z on $x = 10^{m/5}$ must be linear, $E(Z|x) = Ax$; (b) the regression of $Y = (Z - Ax)^2$ on x has the form $E(Y|x) = \sigma^2 + Bx^2$. Here A and B depend on the type of galaxy; the actual shape of the two regressions may be vitiated if the classification of galaxies is not fine enough. The formula for $E(Y|x)$ implies that the estimation of σ^2 reduces to that of the intercept of a quadratic regression. Preliminary results using the data of Humason, Mayall, and Sandage indicate that σ^2 must be small.

Tidal Deformations and the Origin of the Moon. ERNST J. ÖPIK, *Department of Physics, University of Maryland (on leave from Armagh Observatory, Northern Ireland)*.—Results of a provisional survey of the ellipticities of lunar craters in selected areas of Kuiper's *Atlas* are discussed. The rms random ellipticity is found to be 0.070 near the center, 0.096 near the limb, and is probably due to oblique impact. Small preferential components of ellipticity are indicated and interpreted as possible after-effects

of past tidal deformations. Formulae for tidal-rotational deformations of line elements on an elastic nonresisting surface are given. The smallness of the preferential effects is in itself significant, without regard to their absolute value. They suggest that the craters were formed when the earth-moon distance was of the order of 30 000–50 000 km. The undamaged appearance of the craters except for impact erosion and flooding, and the absence of signs of major crustal deformations indicates that since crater formation the moon could not have been at a closer distance. From theoretical rates of accretion as based on probabilities of interplanetary collisions, possible modes of origin of the moon are discussed. If the pre-mare craters mark the end of a continuous process of accretion which built the moon, the observed small systematic deformations of the craters are only compatible with the moon having accreted from a cloud of fragments circling the earth in direct orbits at a distance of 5–8 earth radii or greater. The assumption of different processes for accretion of the moon and for the formation of pre-mare craters leads to improbable consequences. Only when the preferential ellipticities are discounted as due to other causes or to chance, is it possible to accept the alternative of the moon having accreted from interplanetary material orbiting the sun. Accretion must then have run simultaneously with tidal evolution following initial tidal capture, the pre-mare craters having formed at a distance of over 200 000 km from earth as the final stage of this accretion.

Free-Free Emission in the Radio-Frequency Range.

LUDWIG OSTER, *Yale University Observatory, New Haven, Connecticut*.—Classical and quantum-mechanical calculations for the free-free emission (bremsstrahlung) of electrons in a completely ionized plasma are critically investigated. Avoiding altogether the sometimes misleading assumptions found in the literature, it is concluded that the several classical computations are in complete agreement with the quantum-mechanical approach. Numerical coefficients are derived for a Maxwellian distribution of electron velocities. It is shown that for temperatures below, roughly, 550 000°K the classical results can be safely used; however, for higher temperatures quantum corrections are required. Finally, examination of the problem of a cutoff of the ion's Coulomb potential shows that this cutoff can be neglected for all frequencies above the plasma frequency in the range where the refractive index is effectively unity.

Heating of the Solar Chromosphere, Plages, and Corona by Magnetohydrodynamic Waves.

DONALD E. OSTERBROCK, *Institute for Advanced Study, Princeton, New Jersey*.—The energy carried upward by sound waves generated in the hydrogen