lege Observatory.—Using the Harvard 60-ft radio telescope and a maser radiometer, we have studied the microwave OH line complex in 19 directions toward the galactic center. In each direction investigated, the OH spectra appear exclusively in absorption and display multiple components of unusually large half-widths. The absorption spectra were found in the range $l^{\text{II}}=358.5^\circ$ to 4° , ($b^{\text{II}}=0^\circ$), where typical profiles contain three major components ranging in velocity from +140 to -140 km/sec with characteristic half-widths of approximately 80 km/sec. The velocity resolution of the maser radiometer was 15 km/sec.

Three spectra of the OH line complex have been observed for each galactic direction, viz., the $F=2 \rightarrow 2$ (1667 Mc/sec), $F=1 \rightarrow 1$ (1665 Mc/sec), and the $F=2 \rightarrow 1$ (1612 Mc/sec) transitions. For these transitions, the predicted ratios for optically thin lines are 9:5:1 at 1667, 1665, and 1612 Mc/sec. A major result is that the measured line ratios are invariably smaller for each of the observed positions. Several explanations have been offered for the anomalous ratios; the most simple is large optical depths. The hypothesis of line saturation has been tested in detail on a number of individual absorption components. The ratio of observed antenna temperature minima at 1667 and 1665 Mc/sec and the assumption that the theoretical opacities ratios apply allow the calculation of an antenna temperature minimum at 1612 Mc/sec. In 14 cases, we compared the calculated and observed temperatures at 1612 Mc/sec. Within the accuracy limits imposed by radiometer noise, 12 cases satisfy the line saturation hypothesis. This general result suggests that the anomalous line ratios are due primarily to large optical depths ($\sim 1-2$) in directions toward the galactic center. The OH velocity longitude diagram has been compared with similar diagrams for neutral hydrogen. Although the total velocity ranges are comparable, nevertheless, in the galactic central regions there is very little correlation of OH and hydrogen features, and no evidence of the nuclear disk in the OH data. However, considering the great difference in state temperatures of hydrogen and OH, there are effects which could mask similarities in the hydrogen and OH spectra.

Laboratory Photometric Studies Relevant to the Lunar Surface. BRUCE W. HAPKE, *Cornell University.*—Optical characteristics of a variety of rock and rock powder surfaces have been investigated with the objective of better understanding the photometric properties of the lunar surface. The characteristics measured were: the intensity, polarization and albedo of the surfaces as a function of angle and color. The effects of the following properties or treatments have been studied: particle size, compac-

tion, chemical composition, irradiation by γ rays and by H and He ions of solar wind energies. Only rock powders with particle size less than about 5μ appear to be able to simultaneously match several of the optical characteristics of the moon. These fine powders need not be sifted to give the correct photometric function, as previously supposed (Hapke and Van Horn, *Geophys. Res.* **68**, 4545, 1963); indeed, complex surfaces with high backscatter qualities can be produced by dropping the powder in a vacuum. Untreated rock powders do not match the moon; however, irradiation by ~ 100 Coul/cm² of 2 keV H or He ions darkens and reddens all fine rock powders and otherwise brings their photometric properties close to those of the moon. The primary cause of darkening appears to be due to the formation of coatings of nonstoichiometric compounds on the undersurfaces of the particles by the sputtering action of the solar wind. Doses of 10^6 R of γ radiation have no noticeable effects. Chemical composition has only minor effects on properties of ion-bombarded fine powders. Generally, irradiated acidic rock powders are lighter than irradiated basic powders, but their properties are otherwise similar. Irradiated chondritic meteorite powder has too large a polarization and insufficient color to match the moon, probably because of the large metallic Fe content.

The Frequency of Occurrence of [N II] in Planetary Nebulae. KARL G. HENIZE, *Dearborn Observatory.*—Since $H\alpha$ surface brightnesses are often used to estimate the densities and masses of gaseous nebulae, it is important to know the frequency with which [N II] $\lambda\lambda 6548, 6584$ contribute significantly to the intensity of the $H\alpha + [\text{N II}]$ images of nebulae. Since [N II] $\lambda 6584$ is resolved from $H\alpha$ on objective-prism plates taken in the Michigan-Mount Wilson Southern $H\alpha$ Survey, it is possible to use data from this survey to estimate the frequency of occurrence of [N II] in planetary nebulae. After eliminating nebulae with resolved or possibly resolved images (diameter $> 10''$) and nebulae in which the $H\alpha$ intensity is weak, there remain 103 objects for analysis. Of these, 66(± 8)% show no [N II], 17(± 4)% show weak to moderate [N II] and 17(± 4)% show [N II] with a strength equal to or greater than that of $H\alpha$. These results agree well with those of White (*Astrophys. J.* **115**, 71, 1952), who found that 59(± 16)% of a sample of 22 planetary nebulae show [N II] $\lambda 6584$ to be absent or less than 0.1 as intense as $H\alpha$.

Recent Evolutionary History of Some Irregular Galaxies. PAUL W. HODGE, *University of California.*—A combination of photometry of individual