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Goldstone Solar System Radar . . . . . R. F. Jurgens

Caltech/JPL radar astronomers made use of the Very Large Array (VLA), Socorro, NM, during February 1990, to receive radar echoes from the planet Venus. The transmitter was the 70 meter antenna at the Goldstone complex northwest of Barstow, CA. These observations made use of the 27 antennas to provide the resolution of a much larger telescope with size equivalent to the area over which the antennas are spread. These observations contain new information about the roughness of Venus at cm to decimeter scales and are complimentary to information being obtained by the Magellan spacecraft. Some of the more elevated regions on Venus appear especially bright at the radar's 4 cm wavelength. Moreover, as the altitude increases in these regions, the radar brightness also increases. One possible interpretation is that radar-bright material, perhaps from volcanic sources, is more common at higher elevations.

The VLA/Goldstone Titan radar experiment of June 1989 was repeated on 3 consecutive days in July 1990, with somewhat reduced sensitivity due to the 1990 VLA configuration. The 1990 experiment differed significantly from the 1989 experiment by measuring both circularly polarized modes of reflection. This second year's results were very similar to those of 1989: no echo was detected on the first day and a very strong echo was measured on the second. Only 2 hours were obtained on the third day due to VLA equipment problems. These limited data suggest that a very weak echo was building on this third day. The echoes for the middle day were equally strong in both polarizations and nearly identical to the strong echo in the 1989 single polarization experiment. These results are best interpreted as echoes from a highly reflecting, multiple-scattering structure such as ice. These new observations strengthen the similarity of Titan to the radar-reflective properties of Jupiter's giant satellites. Tidal theory arguments predict that Titan is rotating synchronously about Saturn, presenting a fixed face to its primary. However, the two days with strong echoes from 1989 and 1990 fail to line up in longitude by about 30 degrees! The straightforward but premature interpretation of these results is that Titan has significant nutations about the synchronous-locked rotation state. More radar observations of this enigmatic satellite are imperative with as much transmitted power as possible, in particular to provide valuable data for design of the instruments for the Cassini spacecraft mission to the Saturn system. The Titan VLA experiment team consisted of D. Muhleman, B. Butler, and A. Grossman of Caltech and M. Slade of JPL. The Venus VLA team added K. Tryka of Caltech.

1990 was a busy year for observing asteroids with the Goldstone radar. Two close Earth-approaching asteroids -- 1990 MF and 1990 OS -- were observed in July and August. The ranging to 1990 MF provided the highest precision radar measurement to a solar system target (0.375 microseconds), and, at a round-trip light-time of 33 seconds, the smallest fractional precision radar ranging ever done (1 part in 10^8). The Doppler frequency shift observations of 1990 OS from Goldstone ensured that the orbital parameters for this object are known well enough to predict its future close Earth passages. The mainbelt asteroid Prokne was observed from Goldstone in early August 1990. Prokne is the first mainbelt

asteroid to be observed at Goldstone, and became the first object in the 200 km size category to have its radar reflection properties measured at 4 cm. The principal investigator for the asteroid radar observations is S. Ostro of JPL.