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Venus Express bistatic radar at Maxwell Montes

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Four Venus Express (VEX) bistatic radar (BSR) experiments have been conducted since the spacecraft went into orbit in April 2006. Three of these were conducted on alternating days starting on 15 June and were designed to probe Maxwell Montes, which is known from previous Pioneer Venus and Magellan experiments to have anomalously high reflectivity and possibly an imaginary dielectric constant (i100). One of the objectives of these and future VEX observations is to explore the question of anomalous dielectric constant at high elevations on Venus more thoroughly.

The new VEX BSR experiments confirm high reflectivity and dielectric constant, though the signal to noise ratio is lower, the spatial resolution coarser, and the values inferred less dramatic. Because VEX transmits entirely in right-circular polarization (RCP), it is possible to infer the surface dielectric constant from the power ratio in the RCP and LCP (left-circular) signals that reach the receiver on Earth. If the two echo powers are <RR*> and <LL*>, where R and L are the RCP and LCP voltage spectra, <> denotes time averaging, and * indicates the complex conjugate, we can derive the dielectric constant from the ratio <RR*>/<LL*> and knowledge of the incidence angle at the specular point. For example, if <RR*>/<LL*>=1 and incidence angle is 60˚, then dielectric constant is 3. Values within the Maxwell area from VEX BSR are in the range 7-23.

More puzzling is the fact that the new measurements do not show the phase offset that would be expected if the reflecting surface were made of an imaginary (or complex) dielectric. Along with the powers in each receiver channel, we can calculate a cross spectrum <RL*>, which is complex unless the RCP and LCP signals are identical. Part of the phase of the cross spectrum comes from the slightly different RCP and LCP paths through the receiver cabling and electronics. There may be an additional phase

difference if the RCP and LCP echoes pass through a magnetized plasma (such as the Earth's ionosphere). If these two contributions can be modeled by a slowly varying function of time, the remaining phase arises from the surface reflection process itself.

If the surface dielectric constant is real, the phase in the cross spectrum due to reflection is zero (both of the Fresnel reflection coefficients are real). If the dielectric constant is large and completely imaginary (a conductor, such as a metal), the phase of the cross spectrum is 45˚ and almost insensitive to incidence angle. If the dielectric constants inferred from the VEX BSR power ratios (above) are assumed to be entirely imaginary, the expected phases of the cross spectra should fall in the range 23-38˚. The eight measured VEX phases within Maxwell Montes are in the range -11˚ to +19˚ with standard deviations of typically 40˚. Each measurement by itself is not statistically distinguished from the model prediction; but the eight taken as a group suggest that the surface dielectric constant is not imaginary, contrary to the results from Magellan.