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Subject: Final Report for NASA Grant Number: NAG5-6544 (SUNY 431-0479B)

Final Report for NASA Grant Number: NAG5-6544 (SUNY 431-0479B)

Principal Investigator: Jack J. Lissauer
Institution: State University of New York @ Stony Brook
Proposal Title: Observations of Planetary Rings and Small Moons
NASA Program: Planetary Astronomy

We reduced and analyzed radio images of Saturn taken in 1990-1995 at 0.35, 2.0, 3.6 and 6.1 cm wavelength. The latitudinal brightness distribution varies substantially over time (Van der Tak et al. 1999). Detailed modeling of these data shows that NH4SH condenses at the thermochemical equilibrium temperature of 235.5 K only at Northern mid-latitudes. Over most of the planet, condensation does not occur until the gas cools to 190 +/- 5 K. Supersaturation may also cause the dark equatorial region seen in 1995 at 6.1 cm. Observations of the rings show that the West (dusk) ansa is brighter than the East (dawn) ansa by factors up to 2. The magnitude of the asymmetry increases with increasing wavelength and with decreasing distance to the planet. This East-West asymmetry may be due to multiple scattering in gravitational (Julian-Toomre) wakes.

We improved the Monte Carlo scattering code used to model the microwave emission from Saturn's rings at multiple wavelengths. The basic code outlined in Dunn, Molnar, and Fix (2001) describes the rings as a uniform, infinite layer of ice spheres with a finite vertical extent. The particle sizes follow a power law distribution and scatter light according to a linear combination of Mie and isotropic phase functions. These parameters may be adjusted to reflect the physical properties in the scattering properties of the ring particles. This is used to construct a model which can be directly compared to Very Large Array data.

The code has been extended by including anisotropic particle distributions, primarily in the form of the wake structures that are likely to exist in the rings. The wakes are modeled as periodic, infinitely long, rectangular density enhancements. The vertical extent of the wakes equals that of the ring layer. Between the wakes are regions of diminished density so that the optical depth integrated over many wakes matches that of the Voyager occultation experiments.
This allows us to model the brightness temperature as a function of azimuth and look for asymmetric scattering behavior in the rings. By changing the width and relative density of the wakes, we can alter the nature of the gross scattering properties of the rings to match what is seen in our data.

Abstracts/presentations/preprints:

Molnar, L. A., D. E. Dunn, J. C. Cully, D. J. Young 2000, BAAS, 32, 1088, "Modeling of Radio Emission from Saturn's Rings Including Wakes"

Dunn, D. E., L. A. Molnar, I. de Pater, and J. J. Lissauer 2000, AGU Fall Meeting in San Francisco, "Modeling Emission in Saturn's Rings"

Dunn, D. E., L. A. Molnar, and J. D. Fix 2001, Icarus, submitted, "More Microwave Observations of Saturn: Modeling the Ring with Monte Carlo Radiative Transfer Code"

Publication: Van der Tak, F., I. de Pater, A. Silva and R. Millan, 1999. Variability of Saturn's brightness distribution, Icarus 142, 125-147.

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