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Io's Atmosphere Detected by Ground-Based Microwave Spectroscopy . . . . . M. J. S. Belton

Io's corona and extended atmosphere, i.e. the plasma torus and neutral sodium and potassium clouds, have for a long time been the subject of intensive ground-based studies. However our understanding of the mechanisms by which S, O, Na, K and presumably other atoms reach the extended atmosphere has been poorly constrained by lack of knowledge of Io's neutral atmosphere and its relationship to the properties of the surface. SO_2 in some sort of vapor pressure equilibrium (determined by the microphysics of the boundary layer) with surface frost has been a prime candidate for the major constituent, but the presence of much more volatile species, e.g. H_2S and O_2, have also been considered as possibilities. These gases have been searched for, particularly in the UV region of the spectrum, ever since the discovery of active volcanism on Io by Voyager in 1979, but none of them have ever been detected.

E. Lellouch, M.J.S. Belton, I. de Pater, S. Gulkis, and Th. Encrenaz, have now, not only detected but also fully resolved the profiles of two pure rotational lines of SO_2 using the 30-m microwave dish located in southern Spain. The lines (near 222 and 143 GHz) were found in emission showing that early theoretical predictions for a thermally inverted atmospheric structure (i.e. temperature increasing with height from the surface) were correct. The profiles have the character of thermally broadened, but heavily saturated, lines with central brightness temperatures that indicate that only a fraction of the disk is sheathed in SO_2. Lines with effectively identical properties were observed on both leading and trailing hemispheres and at times separated by almost one year. These are characteristics to be expected of a pure SO_2 atmosphere in equilibrium with frost distributed over most of the surface of Io. One of the fascinating aspects of the data obtained so far is that, for a short period of time, the character of the spectrum was observed to rapidly change. The width of one of the lines narrowed while its central intensity increased. A preliminary analysis indicates that for a very short time the total amount of SO_2 on Io must have tripled. It is presumed that a major, but short-lived, volcanic event was responsible for this behavior. Further observations are scheduled.