Water ice absorption map of Pipe Nebura

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Interstellar water ice is one of important materials for interstellar chemistry. Water ice has been observationally detected as an infrared absorption band at 3.07 μm in dark clouds. The results of past observations show that the optical depth of water ice absorption (τ_{ice}) is quantitatively related to visual extinction (A_V) as $\tau_{ice} \sim 0$ for $A_V < A_{th}$ and $\tau_{ice} = q\ (A_V - A_{th})$ for $A_V > A_{th}$, where q is a constant and A_{th} is the threshold extinction which depends on the cloud ([1],[2],[3],[4],[5]).

The observations of water ice absorption require background stars at the opposite side of dark clouds. This fact makes it difficult to obtain the continuous spatial distribution of water ice. We employ an unprecedented method to obtain a water ice absorption map by utilizing Galactic bulge stars as diffuse background light. The target dark cloud is Pipe Nebula which is in the direction toward the bulge and at the distance of 130-160 pc from the earth ([6]). Analyzed data were obtained with the Near-Infrared Spectrometer (NIRS) in the Infrared Telescope in Space (IRTS) ([7]), which was optimized for observations of diffuse light. The IRTS observation covered about half area of Pipe nebula.

The result of the detailed analysis shows that water ice absorption at Pipe nebula follows the A_V-τ_{ice} relation which mentioned above, i.e., τ_{ice} is under detection at $A_V < A_{th}$ and τ_{ice} is linearly correlated with the extinction at $A_V > A_{th}$. The water ice map is compared with CO emission maps obtained with NANTEN telescope ([8]). The result shows that the spatial distribution of water ice is correlated with the dense part of molecular cloud. The relation of τ_{ice} with the strength of ^{12}CO and ^{13}CO emission shows the “threshold” effect similar to the A_V-τ_{ice} relation. We discuss quantitative relations and properties of water ice in Pipe nebula.

References

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