The Composition and Distribution of Dust Along the Line of Sight Towards the Galactic Center

J.E. Chiar[1], A.G.G.M. Tielens[2], D.C.B. Whittet[3], W.A. Schutte[4], A.C.A. Boogert[2,5], D. Lutz[6], E.F. van Dishoeck[4], M.P. Bernstein[7]

[1]*NASA/Ames Research Center, Mail Stop 245-3, Moffett Field, CA 94035 USA*
[2]*Kapteyn Astronomical Institute, P.O. Box 800, 9700 AV Groningen, The Netherlands*
[3]*Rensselaer Polytechnic Institute, Department of Physics, Applied Physics and Astronomy, Troy, NY 12180 USA*
[4]*Leiden Observatory, P.O. Box 9513, 2300 RA Leiden, The Netherlands*
[5]*present address: California Institite of Technology, Downs Laboratory of Physics, Pasadena, CA 91125 USA*
[6]*Max-Planck-Institut für extraterrestrische Physik, Postfach 1603, 85740 Garching, Germany*
[7]*NASA/Ames Research Center, Mail Stop 245-6, Moffett Field, CA 94035 USA*

We discuss the composition of dust and ice along the line of sight to the Galactic Center (GC) based on analysis of mid-infrared spectra (2.4–13

μm) from the Short Wavelength Spectrometer on the Infrared Space Observatory (ISO). We have analyzed dust absorption features arising in the molecular cloud material and the diffuse interstellar medium along

the lines of sight toward Sagittarius A* (IRS3) and the Quintuplet sources, GCS3 and GCS4. Consistent with the uneven distribution of molecular cloud material, the corresponding absorption features vary in

depth across the GC field, whereas absorption features due to dust in the diffuse interstellar medium are observed at approximately constant depth. It is evident from the depth of the 3.0 μm H_2O and the 4.27 μm CO_2 ice features that there is more molecular cloud material along the line of sight toward Sgr A* than GCS3 and 4. In fact, Sgr A* has a rich solid state infrared spectrum which also reveals strong evidence for the presence of solid CH_4, NH_3, and HCOOH in the molecular cloud

ices.

Water-ice exhibits OH stretching and bending modes at 3.0 and 6.0 μm, respectively. This set of absorption features in the SgrA* spectrum is very intriguing, as the 3 μm profile is unlike the one observed in

local molecular clouds (such as Taurus), and the 6 μm feature is actually a blend of absorptions due to other molecules in addition to H_2O. We show through careful comparisons with laboratory ice analogs that solid NH_3 contributes significantly to both features, and makes up 20–30% of the ices, relative to H_2O. Until recently, solid ammonia has eluded detection in molecular clouds; in two local molecular cloud sightlines, detection of the 9.0 μm inversion mode leads to abundances of not more than 15% relative to H_2O-ice.

Hydrocarbon dust in the diffuse interstellar medium along the line of sight to the GC is characterized by absorption features centered at 3.4

μm, 6.85 μm, and 7.3 μm. Ground-based studies have identified the 3.4 μm feature with aliphatic hydrocarbons, and ISO has given us the first meaningful observations of the corresponding modes at longer wavelengths. The integrated strengths of these three features suggest that some form of hydrogenated amorphous carbon may be their carrier. We attribute an absorption feature centered at 3.28 μm in the GCS3 spectrum to aromatic hydrocarbons. Since we only detected this feature,

as well as its C-C stretch counterpart (6.2 μm), toward the Quintuplet region, but not toward SgrA*, one of the key questions that now arises is whether aromatics are a widespread component of the diffuse interstellar medium, analogous to aliphatic hydrocarbons.