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Unveiling the Unseen: The Mid-IR Galactic Disk

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Abstract. The Spitzer mid-infrared (MIR) surveys, Galactic Legacy Infrared Mid-Plane Survey Extraordinaire (GLIMPSE) and MIPSGAL have revealed a new view of the disk of the Milky Way. Hallmarks of the Galactic disk at MIR wavelengths with spatial resolution $<2''$ are bubbles/HII regions, infrared dark clouds, young stellar objects (YSOs)/star formation regions, diffuse dust and extended polycyclic aromatic hydrocarbons (PAHs), and more than 100 million publically available archived stars with measured flux densities at 7 wavelengths and positions accurate to $0.1''$. At mid-IR wavelengths, the cool components in the Galaxy are preferentially bright and highlight physical processes that are not obvious at other wavelength regimes.

Three different types of phenomena seen in mid-IR surveys of the plane are discussed.

MIR Bubbles/HII Regions: Examples of both stellar wind-dominated and radiation dominated HII regions are found. They are easily distinguished in the mid-IR by whether the emission peaks at the location of the central star (radiation dominated) or whether there is a central wind-evacuated cavity around the central star(s) (wind-dominated). Both types of HII regions have warm dust within the ionized plasma traced by 24 μm emission. It is shown that dust should be blown out of the nebulae (large grains) or destroyed by sputtering (small grains) on short time scales relative to the age of wind-dominated HII regions. It is postulated that a continuous source of grains is required to understand the observed MIR emission. All HII regions are surrounded by bright PAH dominated 8.0 and 5.8 μm photo-dissociation shells.

YSOs/EGOs: The MIR signature of young stellar objects is a dusty accretion envelope that is particularly bright at 24 μm. The majority of the MIPSGAL 24 μm point sources and extended emission regions are Galactic YSOs, AGB stars, star forming clusters, and HII regions. Unlike the 8.0 μm emission, which primarily traces PAH emission and is extended throughout the inner Galactic plane, 24 μm emission is spotty and is confined to small regions around YSOs, young star clusters, and AGB stars. Extended green objects (EGOs), are so named because they have excess emission at 4.5 μm when designated as green in false color IRAC images. EGOs are believed to be very young protostars whose bipolar outflows have excited bright H_2 lines when crashing into the ambient interstellar medium. They are also strongly associated with methanol masers (both class I and II).

Infrared Dark Clouds (IRDCs): IRDCs represent the most opaque regions of dark molecular clouds. They are opaque at 8 μm ($A_V \gtrapprox 100$ mag) and are seen in silhouette against the diffuse Galactic 8 μm background. These are the regions in molecular clouds where star formation is taking place, as demonstrated by the 24 μm point sources that are generally seen here. IRDCs provide information on the initial conditions for star formation.

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