Diffuse Galactic Light in Deep Wide-field Imaging by the Dragonfly Telephoto Array

Qing Liu[1], Peter Martin[2], Roberto Abraham[3], Pieter van Dokkum[4], and William Bowman[4], and Steven Janssens[5]

[1]*Leiden Observatory, The Netherlands,* [2]*Canadian Institute for Theoretical Astrophysics, Canada,* [3]*University of Toronto, Canada,* [4]*Yale University, USA,* [5]*Swinburne University, Australia*

Interstellar dust grains in the Milky Way (MW) absorb and scatter the interstellar radiation field (ISRF), producing diffuse radiation referred to as the diffuse Galactic light (DGL), which is one of the major manifestations of the diffuse interstellar medium (ISM). The DGL is resolved into wispy, filamentary structures in dust emission at high Galactic latitudes by all-sky infrared mapping, which became known as 'Galactic cirrus'. Observations of Galactic cirrus can offer unique insights into the physical properties of dust grains (e.g., size distributions, compositions, albedos), scattering anisotropy, and the characteristics of the incident ISRF.

Observations of the optical DGL, however, have not yet been utilized extensively as a tool to study the diffuse ISM, because in the optically-thin regime the signal is very faint, typically only a few percent as bright as the night sky (>26 mag/arcsec^2 in g-band). This leads to the signal being susceptible to various systematics. Only recently have advancements in instrumental design and data reduction tailored for low surface brightness (LSB) science largely mitigated the challenges. These improvements have facilitated the imaging of the optical DGL, opening new opportunities to study the scattered light from MW dust.

In this presentation, I will talk about imaging of the optical cirrus obtained with the Dragonfly Telephoto Array, a telescope optimized for LSB science through its novel instrumental design and data reduction dedicated to control the systematics. By incorporating priors from Planck thermal dust models into sky modeling, we are able to preserve the radiometry of dust-scattered light. Applying these techniques to the ongoing DragonFly Ultra Wide Survey (DFUWS) will provide the community with an unprecedentedly wide (∼10,000 deg^2) sky area of dust foreground map down to 28.5 mag/arcsec^2 in SDSS g-band. I will present early results based on Dragonfly observations using complementary statistical approaches – including intensity statistics and power spectrum analysis – and compare them with those derived from Herschel, WISE, and Planck data. Our findings offer promising avenues for linking the analysis of coherent structures traced by dust-scattered light to the underlying physical processes (e.g., the turbulence cascade) in the ISM. Finally, I will demonstrate why an unbiased characterization of the dust foreground from direct imaging is crucial for extragalactic LSB studies in the era of the forthcoming Vera C. Rubin Observatory.

The survey is expected to be completed this year and will be publicly available. While the survey primarily targets extragalactic science such as ultra-diffuse galaxies, we invite collaborations from the dust community to exploit the broad potential of this dataset across fields.

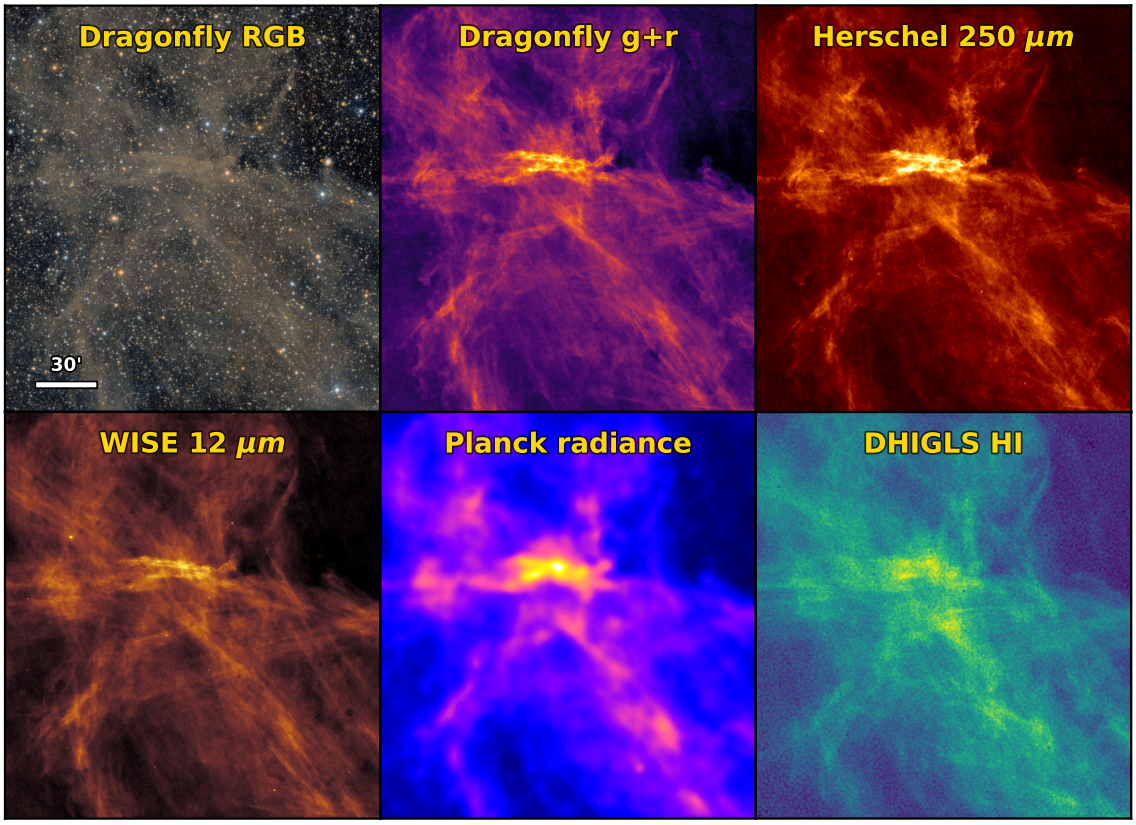

Figure 1: Example dataset of the DGL in different dust tracers. (Liu et al. to be submitted)