

A TESS Full-Sky Map for Low Surface Brightness Astronomy

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Full-Sky Maps from TESS

TESS is a space-based telescope operating in the optical to near-infrared range (600–1040 nm), with a pixel resolution of 21 arcseconds. Its space-based design ensures stable observations and allows for extended exposure times, up to an impressive 27 days [1]. As a result, its full-frame images have a high signal-to-noise ratio. Moreover, B. W. Holwerda has showed that TESS is well-suited for low surface brightness (LSB, $\mu > 25 \text{ mag/arcsec}^2$) structures, which holds clues to the formation and evolution of galaxies[2].

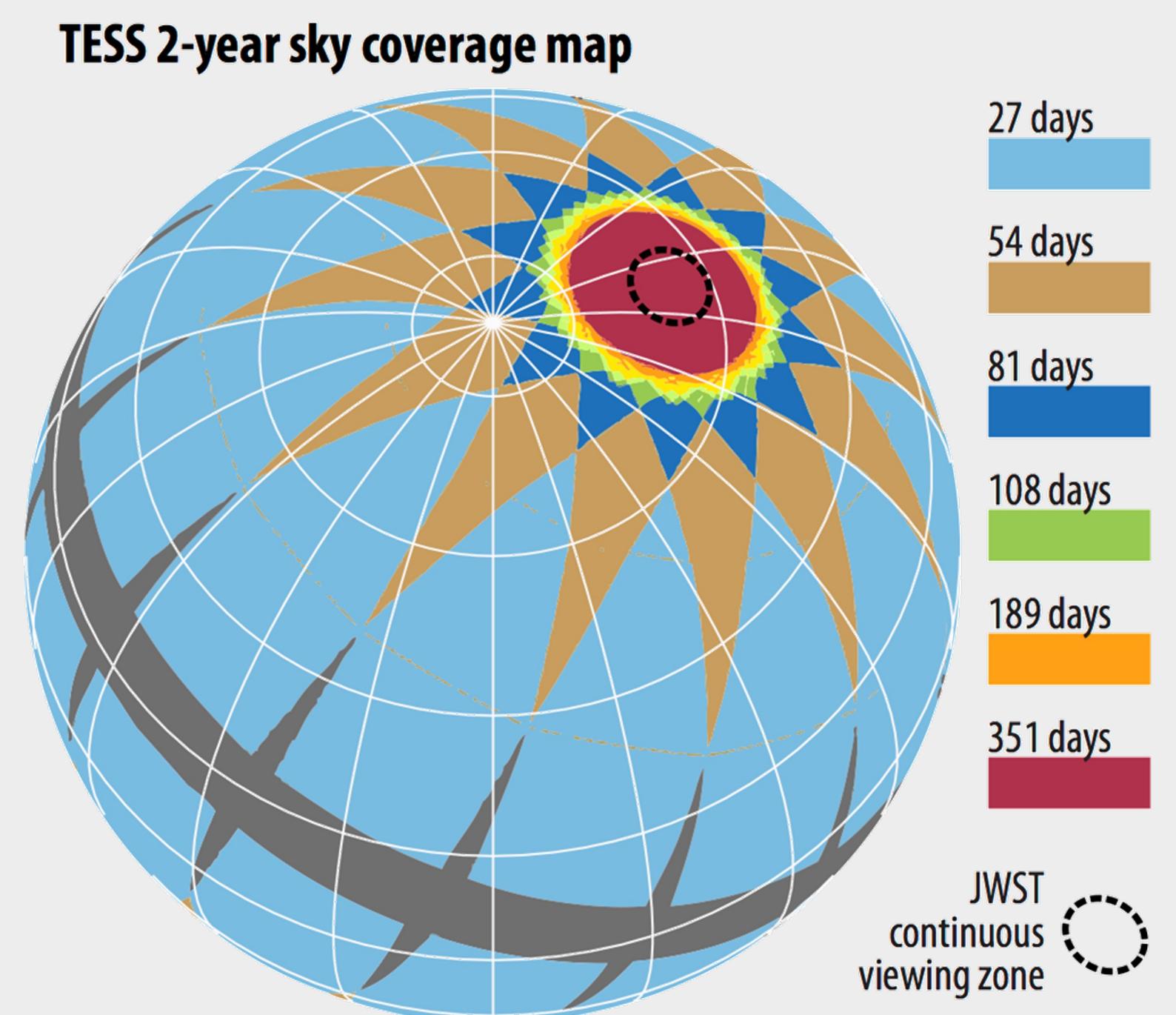


Image Processing

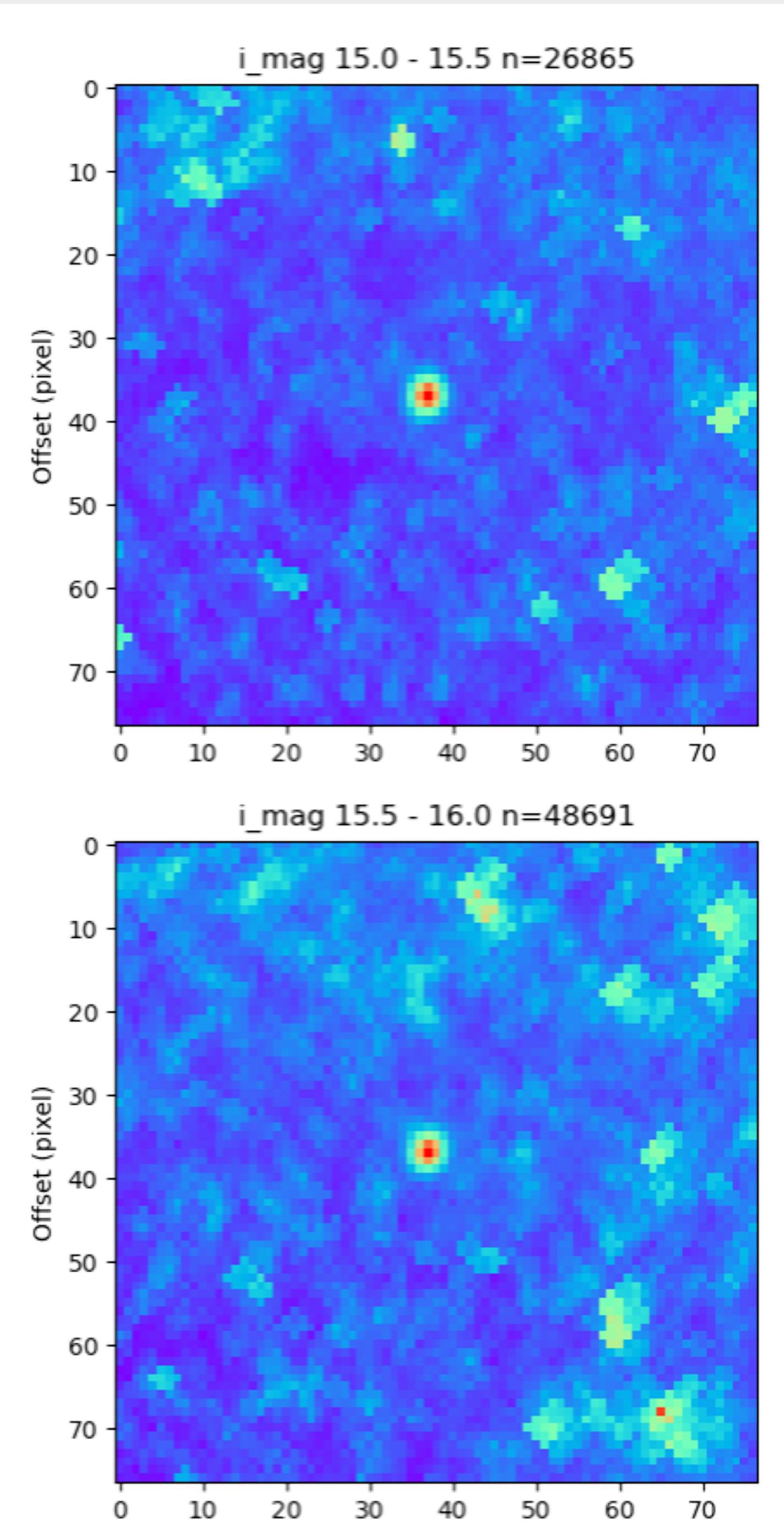
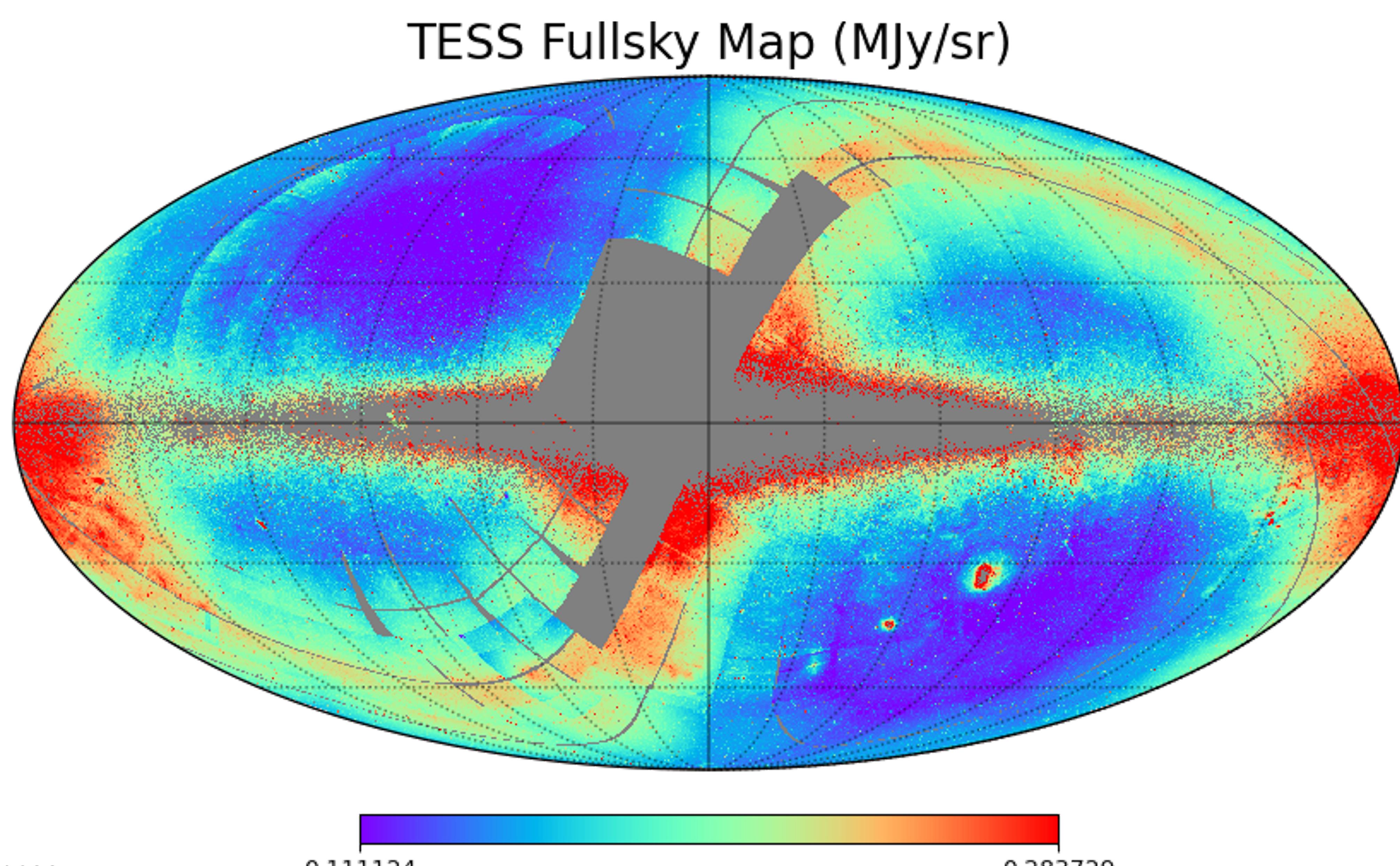
TESS data consists of $67 \times 4 \times 4$ sectors. We first apply a threshold to each sector to remove extreme values, then convert the data to galactic coordinates and mosaic them into a HEALPix map with NSIDE = 2048 (1.7 arcmin resolution). To enhance detection of extragalactic structures, we remove bright foreground stars using the Gaia catalog, excluding stars with magnitudes < 18 , approximately 400 million stars. This reduces the 3-sigma value by a factor of 4, revealing faint diffuse structures more clearly (see lower-left panel).

Benefits of this Map

The biggest advantage is its full-sky coverage, enabling statistical studies across large numbers of specific type of object. Additionally, it provides optical to NIR data with a relatively high signal-to-noise ratio. This makes the map a potential resource for a range of cosmological and galactic studies.

Stacking SDSS Galaxies

We utilize the galaxy catalog from the Sloan Digital Sky Survey (SDSS), selecting sources with i-band magnitudes between 10 and 16. By stacking the images of over ten thousand galaxies, we achieve significant signals (see lower-right panel). These stacking results allow the analysis of extended emission from diffuse stellar halos and offer an approach for estimating the intra-halo light (IHL) fraction.



References

[1] Vanderspek, R., et al. (2018). *TESS Instrument Handbook*, Version 0.1, MIT Kavli Institute.

[2] Holwerda, B. W. (2018). TESS as a Low Surface Brightness Observatory. arXiv preprint arXiv:1806.04485.