Infrared Image Processing for DESI

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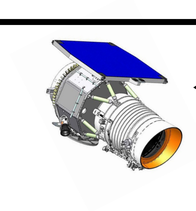
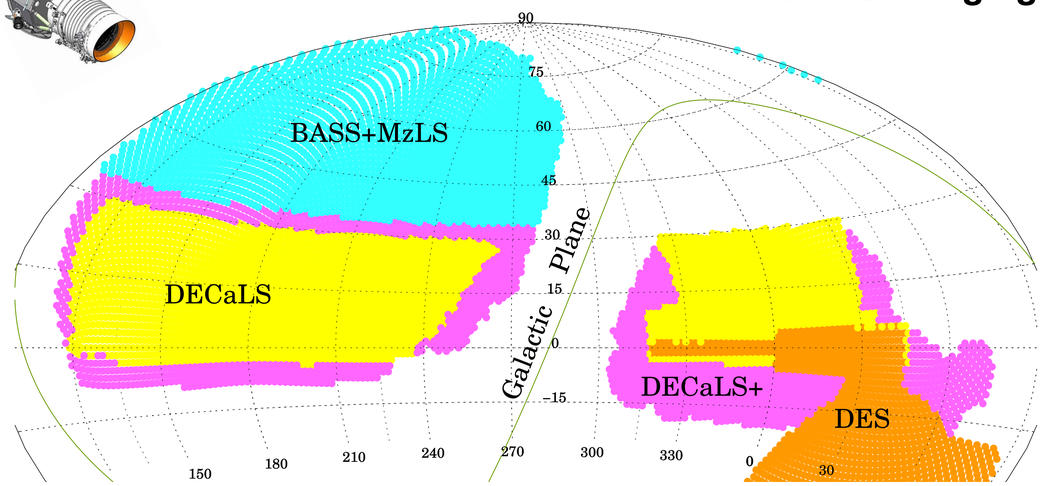
In 2019, the Dark Energy Spectroscopic Instrument (DESI) will begin acquiring 30+ million spectra in order to obtain a new generation of cosmological constraints based on the Universe's three-dimensional large scale structure. Extensive efforts are already underway to acquire and analyze two-dimensional images of the sky regions DESI will observe, to provide targets for spectroscopy. In addition to optical images in three bandpasses, DESI targeting of luminous red galaxies and quasars requires mid-infrared flux measurements. To enable this aspect of DESI target selection, I am leading an ambitious effort to reprocess >100 TB of images from NASA's WISE satellite, creating the deepest ever full-sky maps at 3-5 microns.

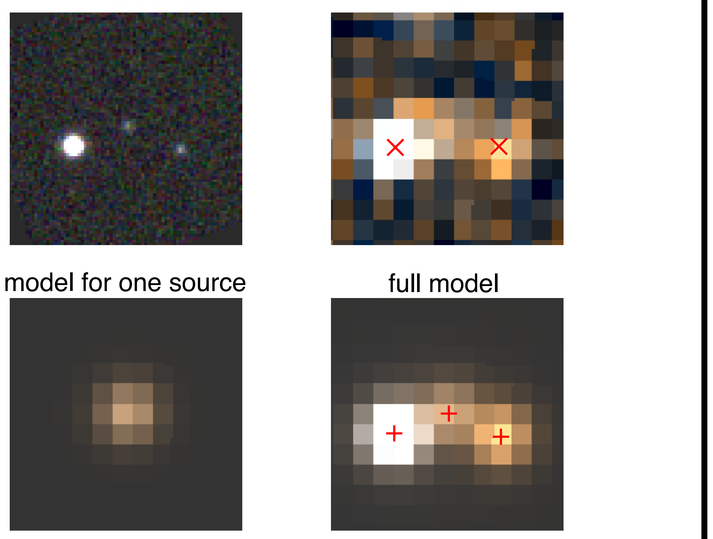


WISE (full-sky)

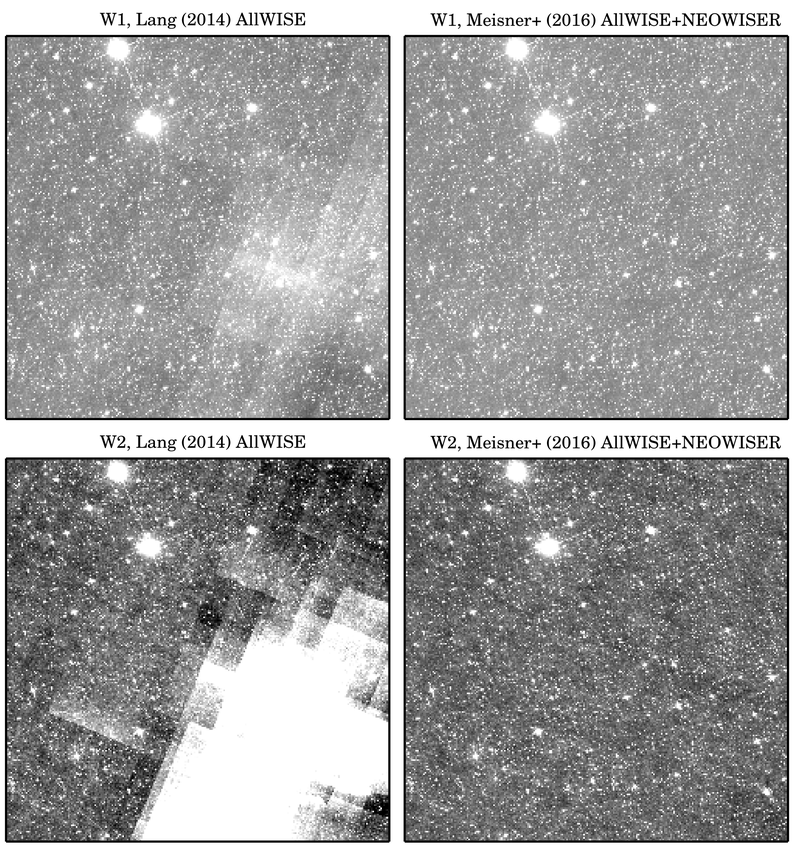
The DESI Imaging Surveys



DESI will observe ~14,000 square degrees of extragalactic sky. The diagram at left illustrates the deep, wide-field imaging surveys currently being performed to enable DESI (DECaLS, DECaLS+, MzLS, BASS), plus additional archival data sets being folded in to DESI target selection (WISE, DES).



DESI imaging reductions employ an inference-based approach to model sources across a wide range of wavelengths. The top left plot shows a DECaLS g+r+z composite. Because the DECaLS data have much higher spatial resolution than the mid-infrared WISE images, a "forced photometry" technique is used to extract infrared fluxes by fitting a model with source centroids and morphologies fixed to those measured in the optical.



By incorporating ~16 million WISE exposures spanning January 2010 to December 2015, we can use the redundancy of repeat WISE imaging to eliminate time-dependent artifacts, thereby enhancing the efficiency and uniformity of DESI target selection.

The dominant systematic on large angular scales in the WISE images is scattered moonlight. The panels below illustrate our procedure for removing the imprint of such scattered moonlight, by modeling it as a low-order polynomial background offset within each affected exposure. NERSC is used to perform all WISE image processing computations for DESI.