SPLICES: the SPHEREx Target List of Ices Sources

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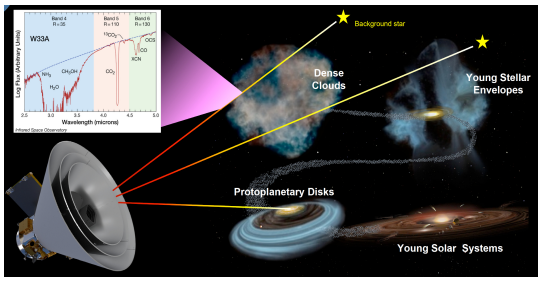
SPHEREx Mission Summary

SPHEREx, the Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer, is an approved NASA Medium-Class Explorer mission designed to:

1. *Investigate the distribution and abundance of water and other key molecular ices in interstellar clouds, YSOs, and protoplanetary disks throughout the Milky Way*
2. *Constrain the physics of inflation by measuring the 3D distribution of more than 3E+8 galaxies*
3. *Explore the origin and evolution of galaxies through a deep multi-band measurement of large-scale clustering*

To achieve these goals, during its baseline 25-month mission SPHEREx will carry out four surveys of the entire sky at 6.2-arcsecond spatial resolution, obtaining 0.75 to 5 μm spectra of billions of sources. Launch is scheduled for 2025.



SPHEREx will conduct absorption spectroscopy toward more than 8.9 million background continuum point sources already catalogued by NASA's Wide-field Survey Explorer (WISE) at 3.4 μm (W1) and 4.6 μm (W2) for which there is:

1. *Evidence for intervening gas and dust based on the 2MASS and WISE colors*
2. *More than 6.2" separation between sources to avoid spatial confusion*
3. *Sufficient flux to yield ice absorption spectra with signal-to-noise (S/N) ratios ≥ 50 per spectral resolution element.*

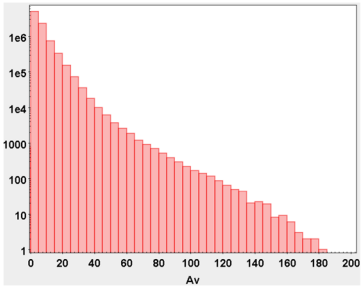
GOAL: SPHEREx will track the ice content and relative ice abundances within molecular clouds as they evolve from diffuse to dense gas and, ultimately, protoplanetary disks. SPHEREx will also identify interesting targets for follow-up study with JWST.

SPLICES Source Selection

The WISE mission all-sky catalog was used as a source of our targets, because of its similar spatial resolution and all-sky coverage. We first employed a sensitivity cut requiring sources to have S/N>50 in the W2 band, which reduced the number of possible targets from 7.5E+8 to 3.5E+7 WISE sources. To focus on targets likely to exhibit ice absorption features in the 3-5 μm range from Galactic molecular clouds, we confined our search to ±15° of the Galactic plane, with some extensions for nearby high-latitude clouds and the LMC/SMC, shown in the figure below.

Sources were required to have an Av >2 (as determined from their H-W2 or K-W2 colors), which corresponds to the estimated minimum column density where ices begin to form on grains in molecular clouds. To avoid confusion, we also rejected sources that had more than one 2MASS-identified source within a 6.2" radius of the source position. After these cuts were imposed, we were left with 8.9E+6 targets in the current SPLICES list. Calibration targets and low-Av reference sources are being added to SPLICES to help calibrate the data and assist in stellar typing and continuum estimation necessary to extract the ice absorption spectra.

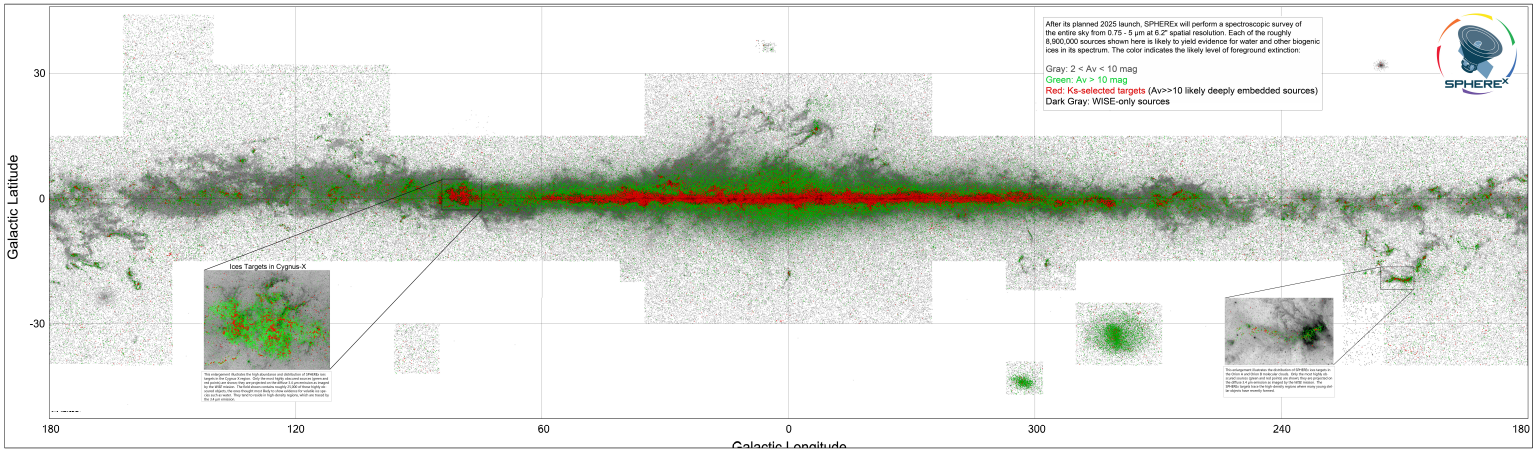
The color criteria was designed to select for main sequence stars that are reddened by dust, but it will also identify intrinsically red objects such as asymptotic giant branch (AGB) stars and active galactic nuclei (AGN). AGB stars are also intrinsically bright, so they will be visible across the Galaxy.

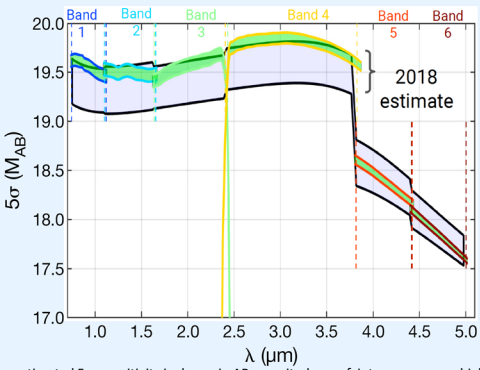


Histogram of the estimated Av values for SPLICES targets, based on the object's 2MASS-WISE colors (*H-W2* or *K-W2*). The vertical axis shows the number of sources in each Av bin.

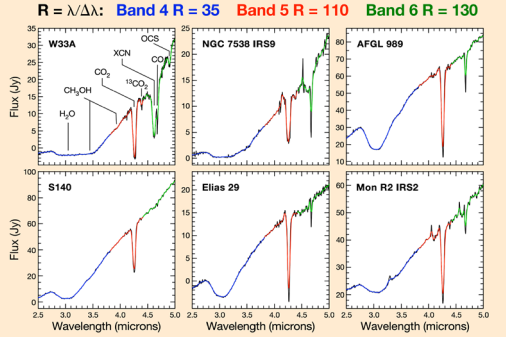
In order to identify possible AGB stars, we used a WISE color-color classification technique to flag objects as potential AGBs, and investigated their variability in the W1 and W2 bands which is a further indication of AGBs.

Young Stellar Objects (YSOs) and proto-planetary disks are an important part of the Ices investigation. To ensure we included as many sources as possible in these categories, we conducted a literature search of previously identified sources, and added those targets that satisfied our S/N and neighbor proximity criteria and were not already in the SPLICES catalog. We have also added ice absorption targets already observed by JWST for comparison to ensure our results are consistent.

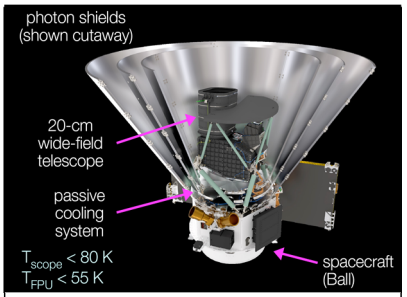




The estimated 5-σ sensitivity is shown in AB magnitudes, so fainter sources are higher in this plot. The lower black curve corresponds to the required sensitivity, the green band shows the current estimate of in-flight performance.



The SPHEREx spectral resolving powers were chosen to produce spectra in which the key ice absorption features are spectrally separated. Above are ISO/SWS spectra (in black; R~1000) with simulated SPHEREx spectra superimposed in bands 4, 5, and 6 (R = 35, 110, and 130, respectively).



SPHEREx employs a 20-cm, off-axis aperture with a total field of view of 11.3°×3.5° coupled to six 2K×2K H2RG detector arrays. The optics are passively cooled using a 3-stage V-groove system. A series of three nested conical photon shields (shown above) protect the cooler and optics from heating by the sun and earth. SPHEREx will operate in a low-earth, sun-synchronous orbit, performing one scan of the sky every 6 months.

SPHEREx web site:
https://spherex.caltech.edu

SPLICES catalog:
https://irsa.ipac.caltech.edu/data/SPHEREx/SPLICES

SPLICES paper:
Ashby, M. L. N. et al., 2023, ApJ, 949, 105

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