SPHEREx: Science Opportunities for the Astronomical Community

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Summary

- SPHEREx is an all-sky survey satellite designed to address all three science goals in NASA’s astrophysics division: probe the origin and destiny of our Universe; explore whether planets around other stars could harbor life; and explore the origin and evolution of galaxies.
- SPHEREx will complete the first all-sky near-infrared spectral survey (0.75 - 3.9 microns at R = 41.5 and R=4.0 to 4.8 at R=150).
- The key science topics are: (a) primordial non-Gaussianity through 3-dimensional galaxy clustering; (b) extragalactic background light fluctuations; and (c) ices and biogenic molecules in the interstellar medium and towards proto-planetary environments.
- The large legacy dataset of SPHEREx will enable scientific studies and interesting targets for follow-up observations with Hubble, JWST, ALMA, SPICA, among other facilities.
- The SPHEREx catalog will include 1.5 billion galaxies with redshifts secured for more than 10 and 100 million with fractional accuracies in error/(1+z) better than 0.3% and 3%, respectively.
- The spectral coverage and resolution provided by SPHEREx are adequate to determine redshifts for all WISE-detected sources with an accuracy better than 3%.
- SPHEREx catalog will contain close to 1.5 million quasars including several hundred bright QSOs during the epoch of reionization. The catalog will be adequate to obtain redshifts for all 25,000 galaxy clusters expected to be detected in X-rays with e-Rosita.
- SPHEREx will also produce all-sky maps of the Galactic emission lines, including hydrocarbon emission around 3 microns.

SPHEREx Data Release Schedule

- DR1 to DR8: Fully calibrated spectral imaging data will be released at every 3 month intervals, starting from 6 months of survey start, composing of 3 months of survey data.
- Major data releases:
  - MDR1: 12 months after survey start, calibrated imaging data (2 passes over the whole sky).
  - MDR2: 24 months after survey start: all-sky survey with 2 passes, calibrated images and the all-sky spectral catalog
  - MDR3: 6 months after survey completion: all-sky survey with 4 passes, calibrated images and the all-sky spectral catalog
  - MDR4: 12 months after survey completion: final catalog, individual band images of the deep fields.
- Data to be archived with catalog access tools from IPAC/IRSA.

SPHEREx Community Science Workshop

- Astronomical community is invited to participate in a community science workshop at Caltech. For details and registration please visit http://spherex.caltech.edu/Workshop.html

SPHEREx Community Participation

- SPHEREx team is inviting input from the science community on potential science applications, data analysis needs, and software and ancillary data necessary to enable such sciences with the SPHEREx data.
- SPHEREx team will use such input to design the best analysis and catalog access tools.
- For details and contact information, please visit the SPHEREx website at spherex.caltech.edu.

Notable features of the SPHEREx All-Sky Survey spectral catalog

- High S/N spectrum for every 2MASS source
- Solid detection of faintest WISE sources
- Redshifts for more the WISE W1/W2 detected sources (>90% complete for W1 detections)
- Catalogs ideal for JWST target selections

Object

<table>
<thead>
<tr>
<th>Legacy Science</th>
<th># Sources</th>
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</thead>
<tbody>
<tr>
<td>Detected galaxies</td>
<td>1.4 billion</td>
</tr>
<tr>
<td>Galaxies ((s(1)/(1+z) &lt; 0.03))</td>
<td>120 million</td>
</tr>
<tr>
<td>Galaxies ((s(1)/(1+z) &lt; 0.003))</td>
<td>9.8 million</td>
</tr>
<tr>
<td>QSOs</td>
<td>&gt; 1.5 million</td>
</tr>
<tr>
<td>QSOs at z &gt; 7</td>
<td>0-300</td>
</tr>
<tr>
<td>Clusters with &gt; 5 members</td>
<td>25,000</td>
</tr>
<tr>
<td>Main sequence stars</td>
<td>&gt;100 million</td>
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<tr>
<td>Mass-losing, dust forming stars</td>
<td>Over 10,000 of all types</td>
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<tr>
<td>Brown dwarfs</td>
<td>&gt;800, incl. &gt;40 of types T and Y</td>
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<tr>
<td>Stars with hot dust</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Diffuse ISM</td>
<td>Map of the Galaxy</td>
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Spectra of M supergiants, Oh/IR stars, Carbon stars. Stellar atmospheres, dust return rates, and composition of dust

Atmospheric structure and composition; search for haze. Informs studies of giant exoplanets

Discover rare dust clouds produced by cataclysmic events like the collision which produced the Earth’s moon

Study diffuse emission from interstellar clouds and nebulae; (H, CO, S, H2O and PAN emission)