TeraHertz Space Telescope (TST)

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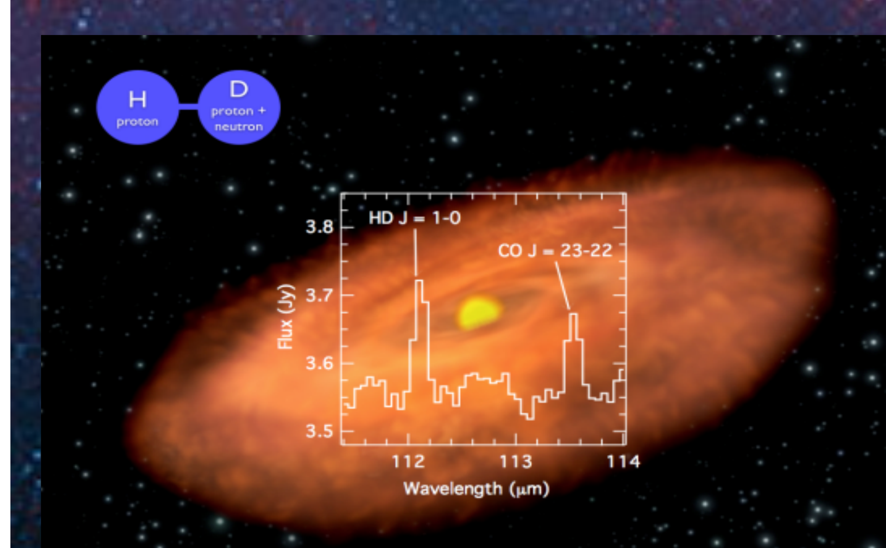
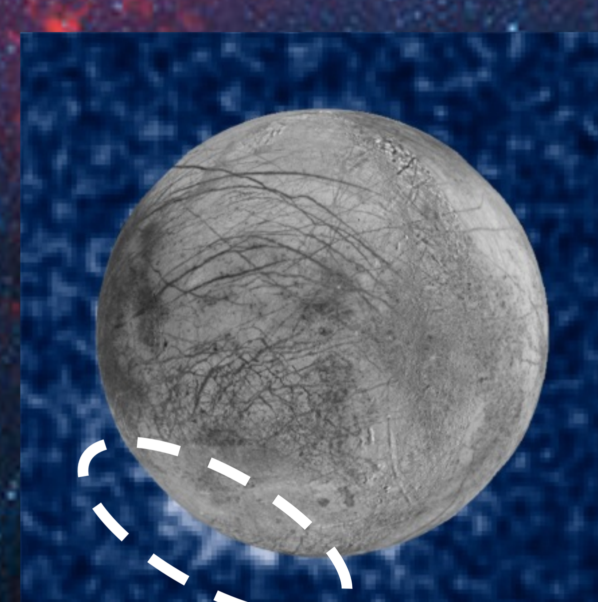
What Is TST?

The TeraHertz Space Telescope (TST) utilizes breakthrough inflatable technology to create a large-aperture, far-infrared observing system at a fraction of the cost of conventional space telescopes. TST is an affordable 25m space-based observatory concept that enables the exploration of the THz/FIR regime in unprecedented detail and is an excellent match to the Astrophysics Visionary Roadmap and the cost envelope of a Probe Class mission. A spherical reflector is formed from the metallized portion of an otherwise transparent ~60 meter diameter sphere made of ~0.5 mil acetate film. Internal dielectric structural curtains are used to define a spherical surface figure and differential pressure control is used to maintain it throughout the mission. The instrument module is held at the nominal focal position by dielectric curtains and houses an adaptive spherical corrector, as well as coherent and incoherent imaging systems. The spacecraft bus provides power, station keeping, coarse pointing, and communications.



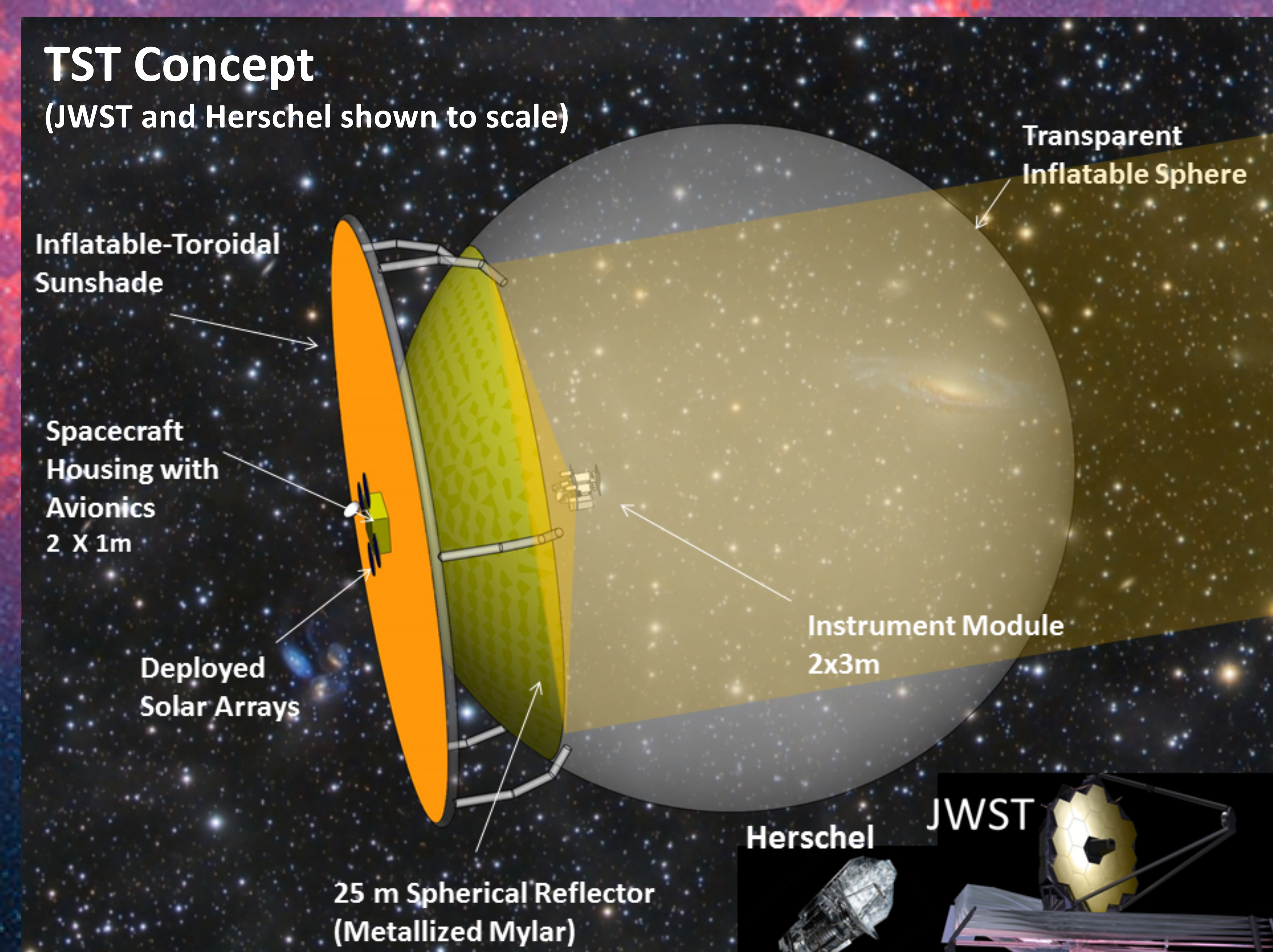


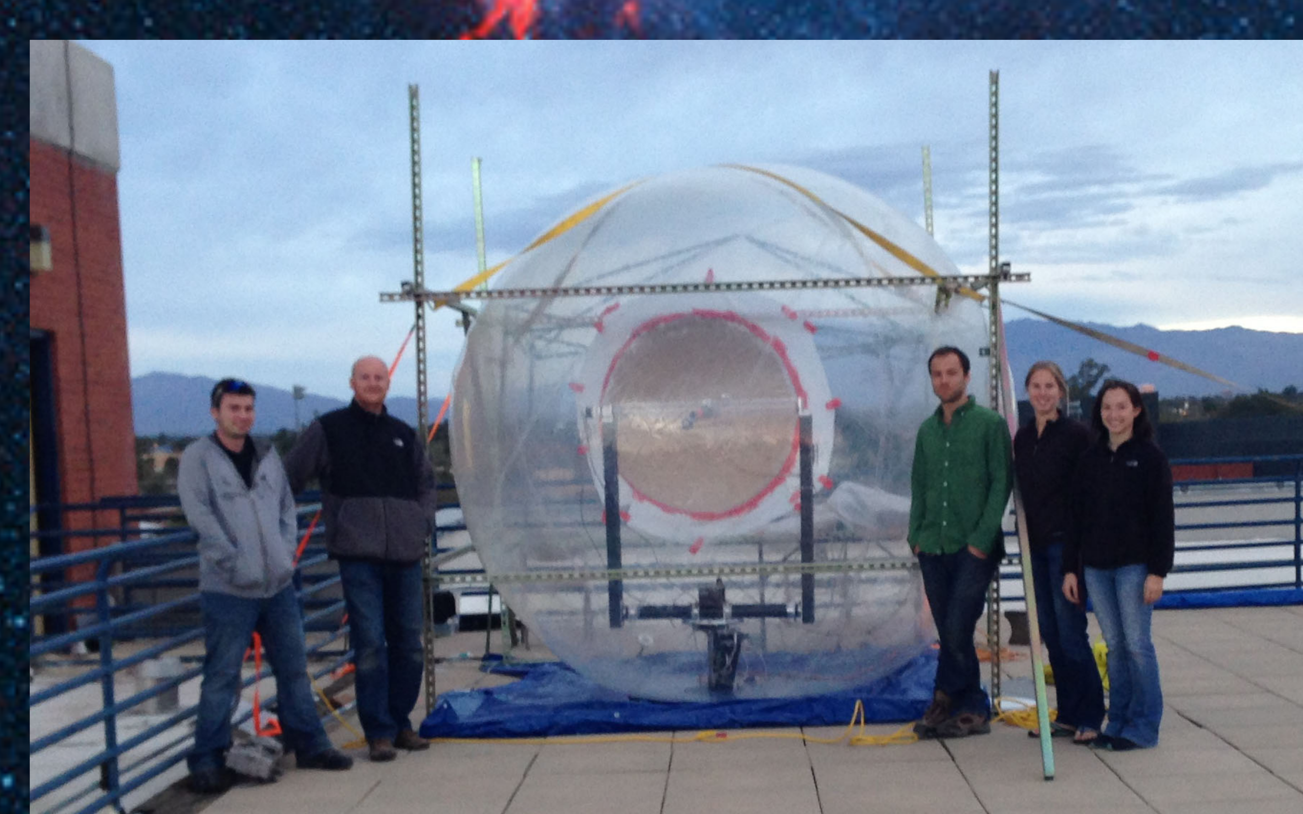
Probing Protoplanetary Disks: Fundamental rotation transition of HD at 112 μm from the TW Hya disk observed using the Herschel Space Observatory (Bergin et al. 2013). **TST will be able to probe such disks at distances ~50x further away.**

Outgassing on Europa: (composite image from Hubble on Jan. 26, 2014). **TST will be able to image such events on solar system objects and use high resolution THz spectroscopy to determine the composition of outgassing materials.** *Credit: NASA/ESA/W. Sparks (STScI)/USGS Astrogeology Science Center*

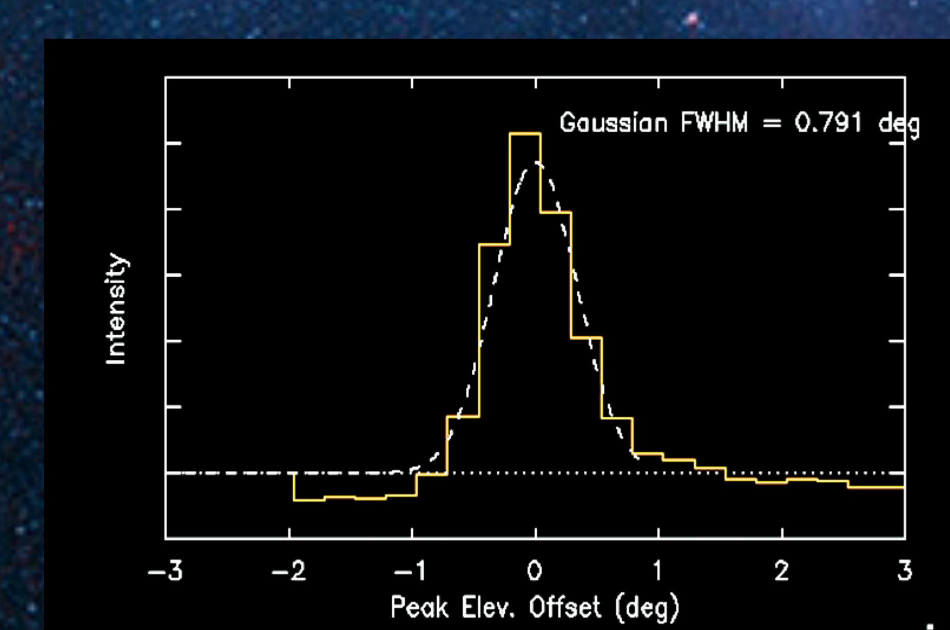
What Will It Observe?

At Terahertz frequencies, a wavelength range of approximately 300-30 μm, we have the ability to study the life cycle of the interstellar medium (ISM) of the Milky Way and other distant galaxies in great detail. As a follow-on to JWST, TST will revolutionize our understanding of the origin and evolution of galaxies, stars, and the ISM. TST will also permit a detailed study of protoplanetary systems and solar system bodies throughout the far-infrared.



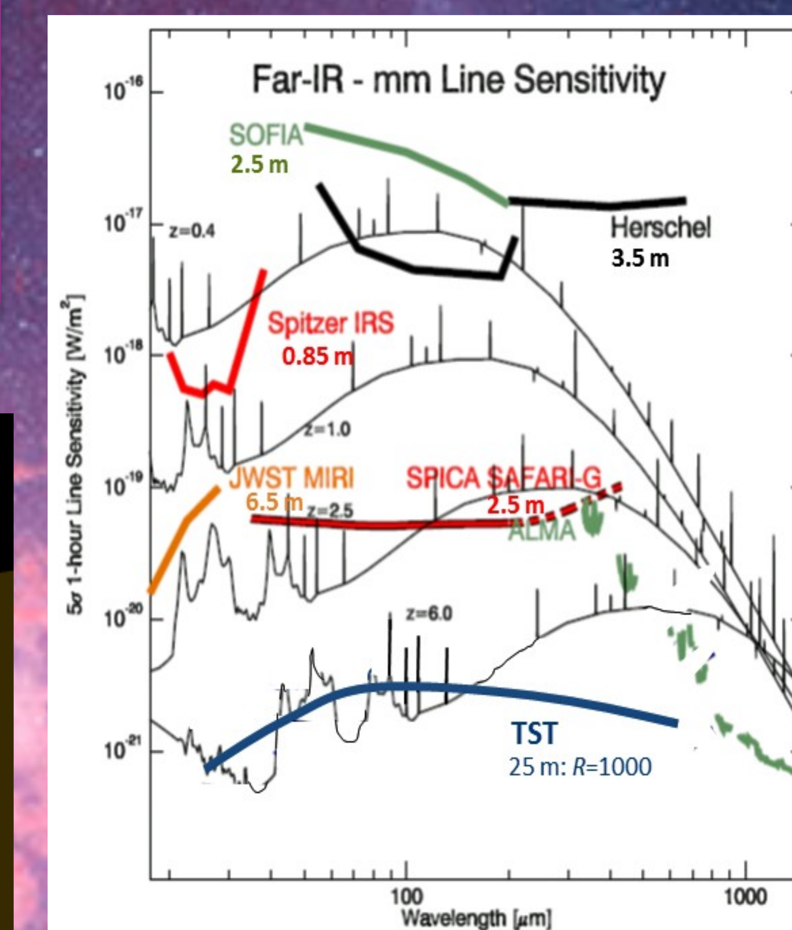


3 meter Rooftop λ~3mm Prototype Constructed under NIAC Program



Beam Scan on Sun
Demonstrates Diffraction Limited Performance

TST Sensitivity Comparison



TST Sensitivity Compared to Past, Present, and Proposed FIR/THz Missions

The large aperture and operating temperature (~50K) of TST provides major advantages in terms of scientific performance and simplicity of implementation. TST is a powerful observatory that can be used to probe many aspects of cosmic evolution, from the formation of the first galaxies to the formation of nearby planetary systems.
(SED template from Bradford, FIR Surveyor STDF).

Mission:
Duration: 5 years
Orbit: Sun-Earth L2
Launch readiness: 2024
Mission type: Probe-Class; estimated cost ~$800M

Spacecraft:
Attitude Control: 3-axis stabilized
Pointing requirements: ~0.1"
Launch mass: ~400 kg
Launch dimensions: ~2.5 x 4 m
Max downlink rate: ~10 Mbps, K_a-band

Telescope & Instrument :
Telescope: 25 m inflated, spherical reflector radiatively cooled to ~50K
Frequencies: ~1 to 10 THz (300 to 30 μm)
Angular resolution: ~0.3 to 3 arcsec
Instruments:
Wide-Field Active Spherical Corrector
Coherent & incoherent cameras
Sensitivity: ~3×10^{-21} watts/m^2
Spectral resolution: ~10^6 to 10^3
Cryogenic system: 2- cryocoolers + dilution fridge
Power: ~1 kW, mass: ~200 kg
Heritage: Herschel, SOFIA, STO, LBR