Cosmic Origins Science Objectives Drive Far-IR Measurement Requirements

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Recipe for success

- Traceability to the astrophysics community's prioritized science goals is essential

… but not sufficient. Also need to:

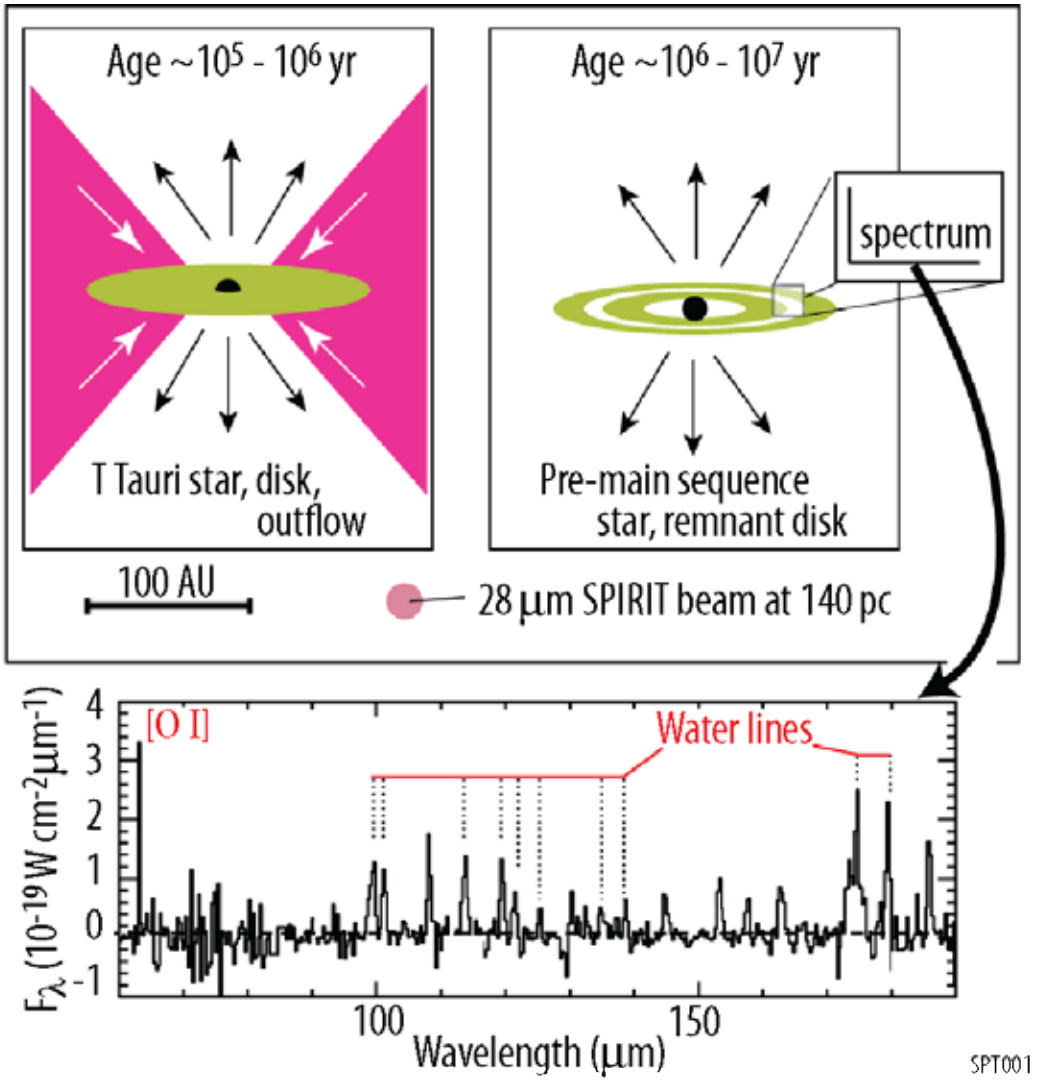
- capture the public's imagination (e.g., learn how habitable worlds form)
- use space only if it can't be done on the ground
- be affordable
- align with international partners
- prepare the enabling technology

NWNH goals drive the need for a future far-IR observatory (1)

- **Discover how the conditions for habitability arise during planetary system formation**
  - **How do worlds such as our own come into being? (p. 2-16)**
  - **Explain the diversity seen among planetary systems. (p. 2-14)**
  - **What fraction of circumstellar disks turn into planets? (p. 2-24)**
  - **Find and characterize planets with the features that allow for life around stars other than the Sun. (p. 2-25)**
  - **Understand the origins of stars and planets, and ascertain the frequency of potentially habitable worlds. (SFP p. 4-1)**
  - **Map the physical and chemical composition of protoplanetary disks on AU scales (SFP p. 4-27)**
  - **Study at ever more powerful spectral and spatial resolution astrophysical environments (proto-planetary disks, transition and debris disks, and planetary atmospheres) in which organic molecules occur and evolve. (p. 2-33)**

Water, water everywhere! (Some gaseous, some solid.)

How do the conditions for planet habitability arise during planet formation?

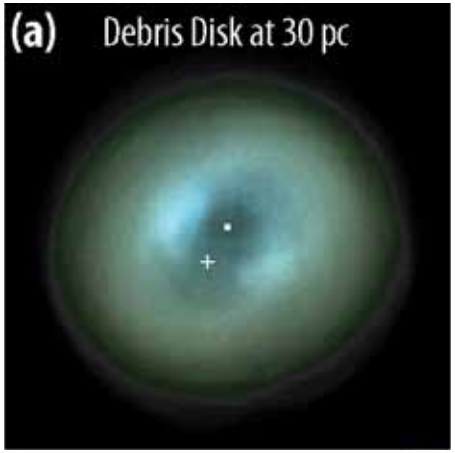


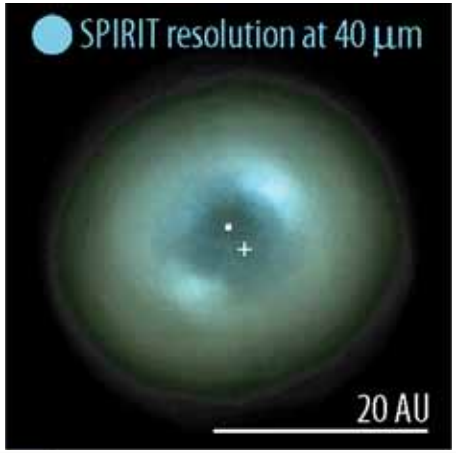
NWNH goals drive the need for a future far-IR observatory (2)

- **Find and characterize exoplanets by measuring their sculpting effects on protoplanetary and debris disks**
  - **Resolve images of debris disks; look for changes on orbital time scales (SFP p. 4-27)**
  - **Novel methods need to be encouraged for the detection of planets far from their stars (SFP p. 4-29)**
  - **How diverse are planetary systems? (p. 2-17)**
  - **Characterize disk gaps and outer disk structure in transitional disks. (SFP p. 4-27)**
  - **Find and characterize infant giant planets in proto-planetary disk gaps and debris disks. (SFP p. 4-27)**
  - **Understand the basic mechanisms of the formation of giant planets, and planet migration (SFP p. 4-28)**

Find and characterize planets by detecting lumps of gravitationally trapped dust in debris disks.

Kuchner et al. Eps Eri model scaled to 30 pc

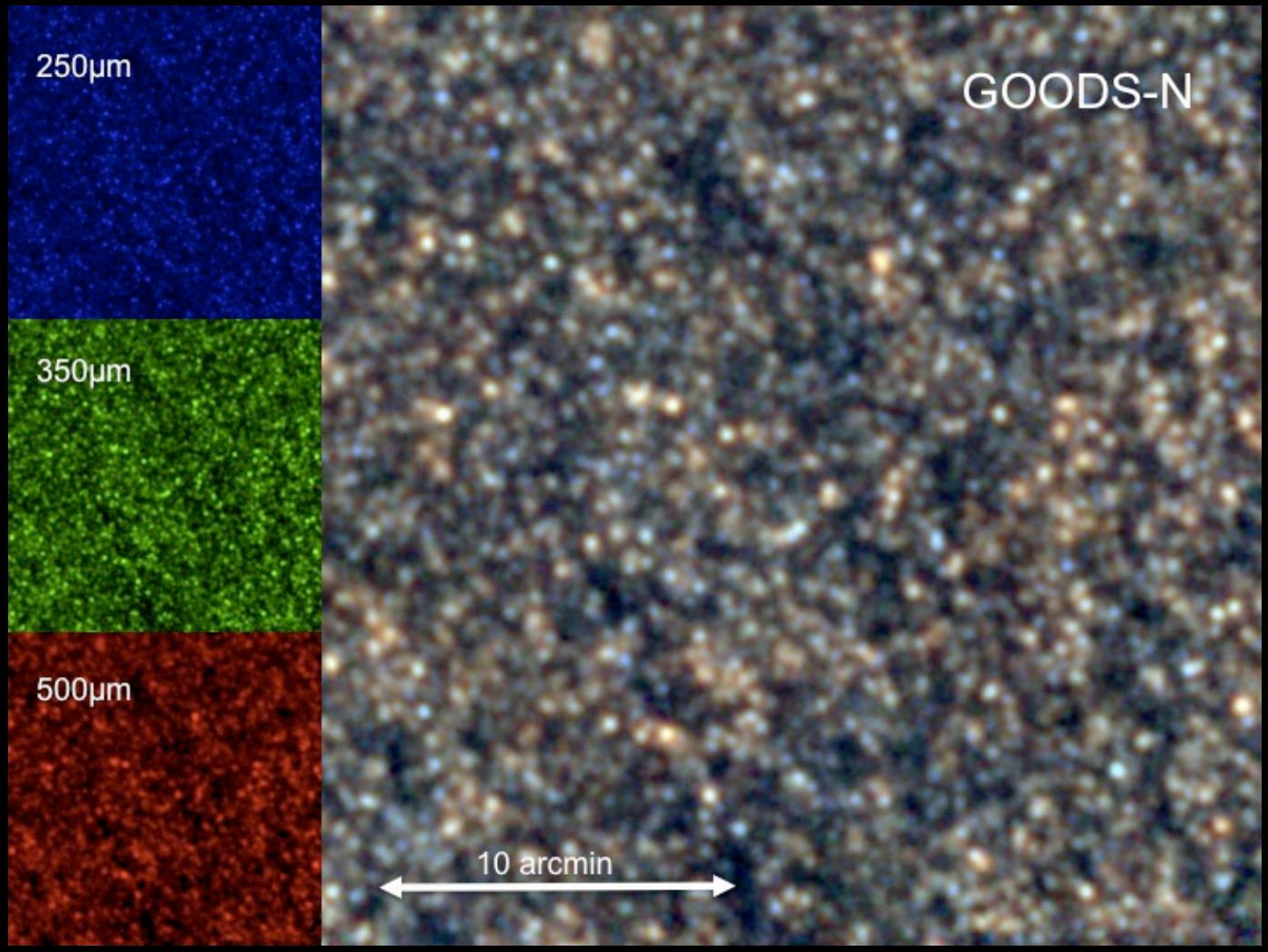




NWNH goals drive the need for a future far-IR observatory (3)

- **Study the formation, merger history, and star formation history of galaxies**
  - **a 13-billion-year-long movie that traces the build-up of structure since the universe first became transparent to light (p. 2-13)**
  - **Understand the process of star formation over cosmic time (p. 2-15)**
  - **trace the build-up of the heavy elements [and dust] (p. 2-14)**

Herschel GOODS-N Deep Field



How did high-z galaxies form and merge to form the present-day population of galaxies?