



## Ambitious Goal:

# Image Key Stages of Planet Formation

- Planet formation is one of the most exciting fields in astronomy
- Connects star formation with exoplanets
  - How to explain exoplanet demographics, architectures
  - Detect young giant planets themselves
- Robust theory & simulation efforts are underway
- Benefits from a range of facilities
  - Poised for many advances with VLT/MATISSE, ALMA, GPI/SPHERE, ELTs
- We expect complexity beyond what ALMA and single apertures can ever resolve



# What are the relevant spatial scales?

24 $\mu$ m thermal  
emission from  
small dust grains

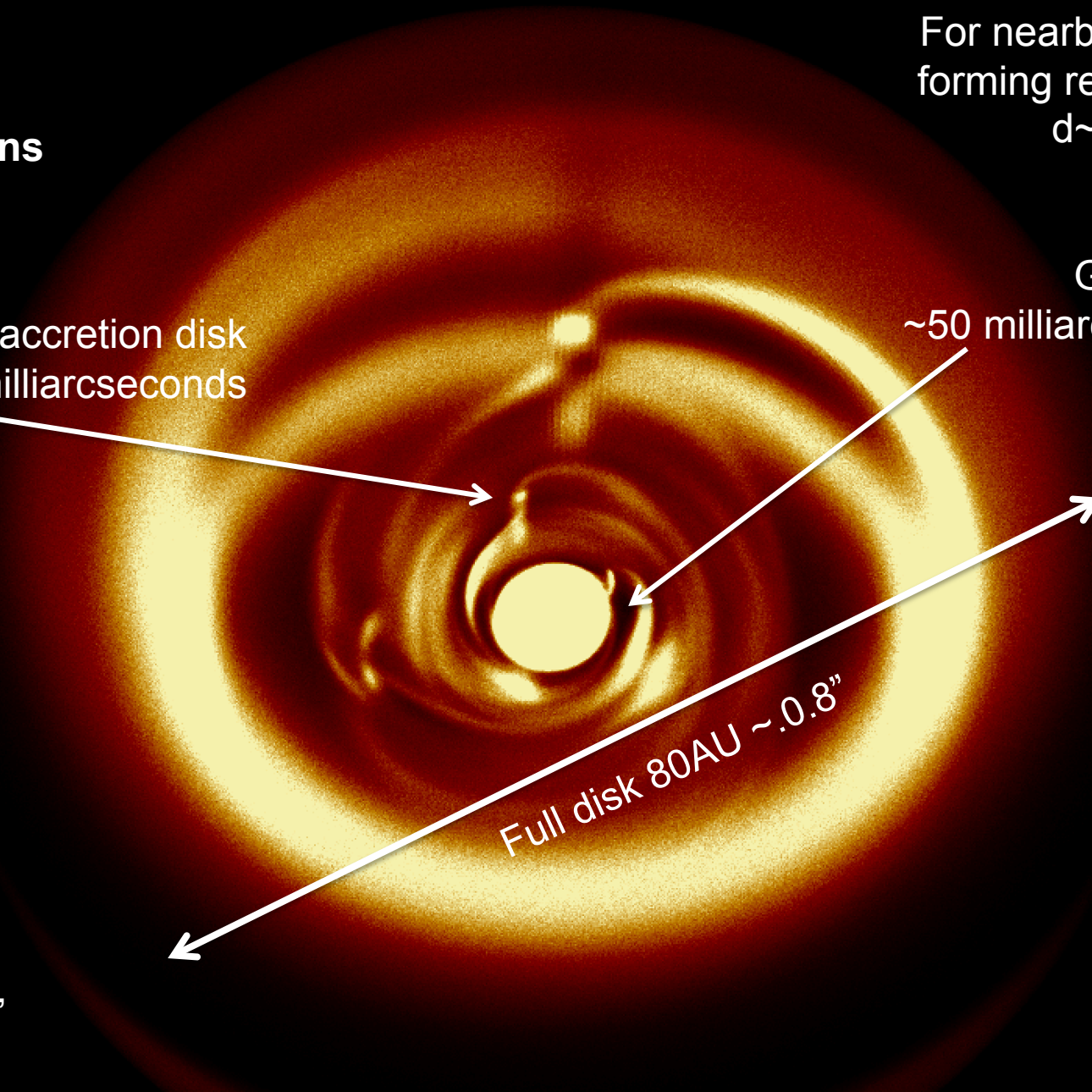
For nearby star-  
forming regions,  
d $\sim$ 100pc

Circumplanetary accretion disk  
0.03 AU = 0.2 milliarcseconds

Gaps 5AU  
 $\sim$ 50 milliarcseconds

Full disk 80AU  $\sim$ 0.8''

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# Top-level Science Requirements

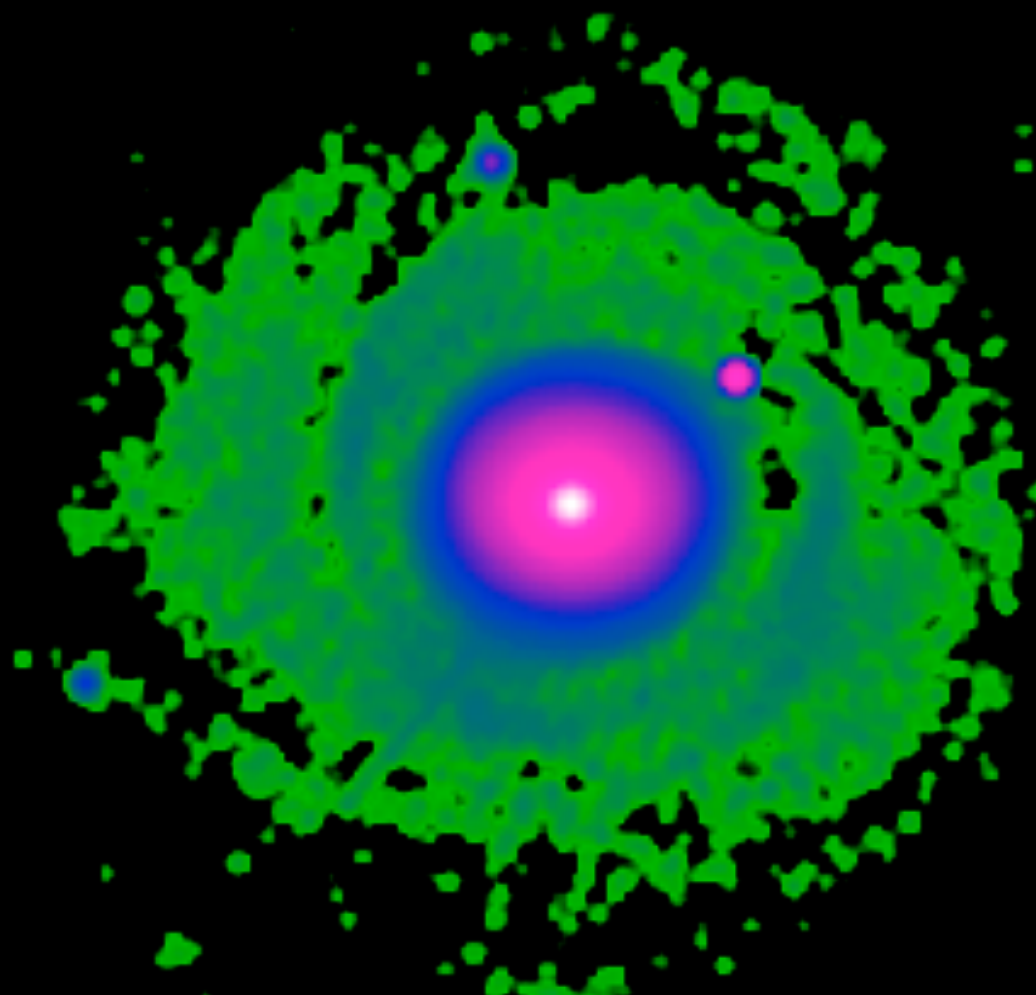
(abbreviated)

- Resolve “Hill-sphere” size region of **Jupiter at 1 AU (0.03 AU)**
  - for nearby star forming region (140pc) → **0.2 milliarcseconds**
- Sensitivity to thermal emission
  - for 300K grains → mid-IR (10 microns)
- Angular Resolution of up to 0.2 milliarcseconds (TBD)
  - For 10 $\mu$ m → **requires 10km baselines**
  - For 3 $\mu$ m → **requires 3km baselines**
- Sensitivity to see a circumplanetary disk and **even planets themselves**
- Very complex scenes.. 200x200 pixel imaging
- **SECONDARY: imaging AGN dust tori, mass loss, stellar surfaces...**



# Planet Formation Imager Architecture

- Basics
  - Mid-infrared key science, 3-13  $\mu\text{m}$
  - Up to 7 km baselines
  - 2m *minimum* telescope diameter for NIR fringe tracking
    - Natural guide star AO is sufficient for YSO case
    - 4meter telescope gives better margin
  - 8m maximum telescope diameter to maintain at least 0.25" field of view
  - $N > 10$  telescopes due to complex imaging
- **Technology Developments Needed**
  - Inexpensive 3m class telescopes (\*COST DRIVER\*)
  - Sensitive fringe tracking demonstration
  - Kilometric baselines w/ delay lines, beam transport, high throughput
  - Beam combiners for  $N > 10$  telescopes
  - Low-cost operations model



# The “Planet Formation Imager” Project

*[planetformationimager.org](http://planetformationimager.org)*