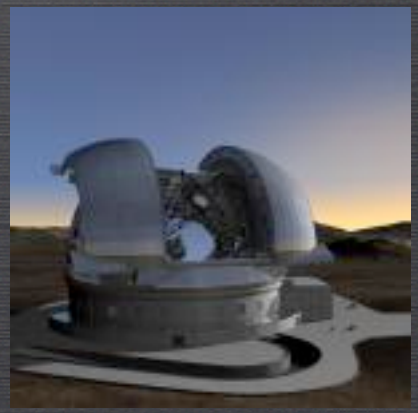
Imaging the Planet-Forming Regions of Circumstellar Disks

Daniela Villegas

Science Case PI:
Mark McCaughrean

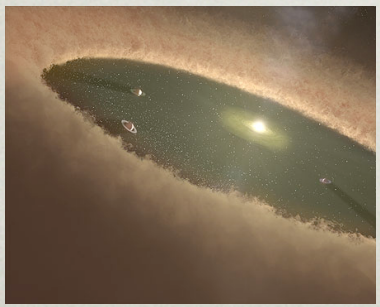
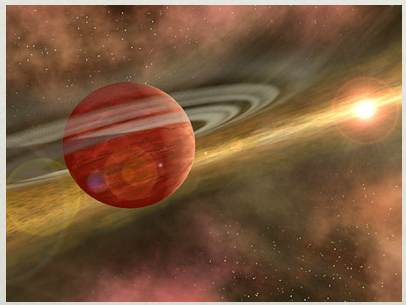
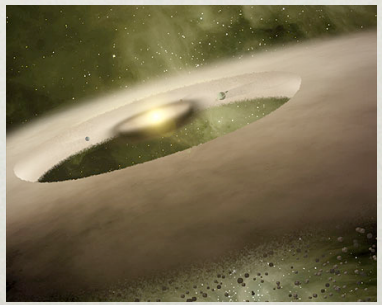
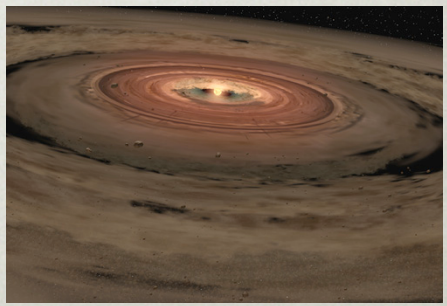


Circumstellar Disks

Circumstellar disks play a fundamental role in the formation of star and planets.

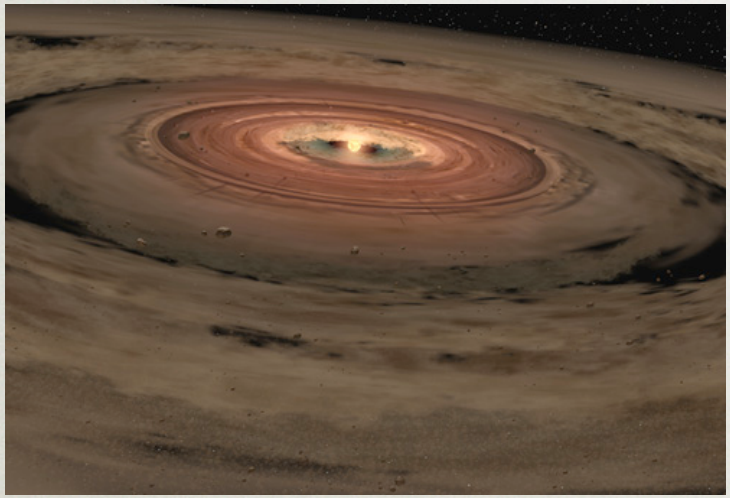
They are involved in a number of processes such us:

- mass accretion onto the central star
- launching of stellar jets and outflows
- mass agglomeration leading to planet formation

Circumstellar Disks

- Accretion



Circumstellar disks provide a conduit for mass accretion onto the central star.

Theoretical progress on identifying the plausible accretion mechanisms has been made, but there is little observational evidence to support them.

The dynamics of the gas in the inner disk needs to be studied.

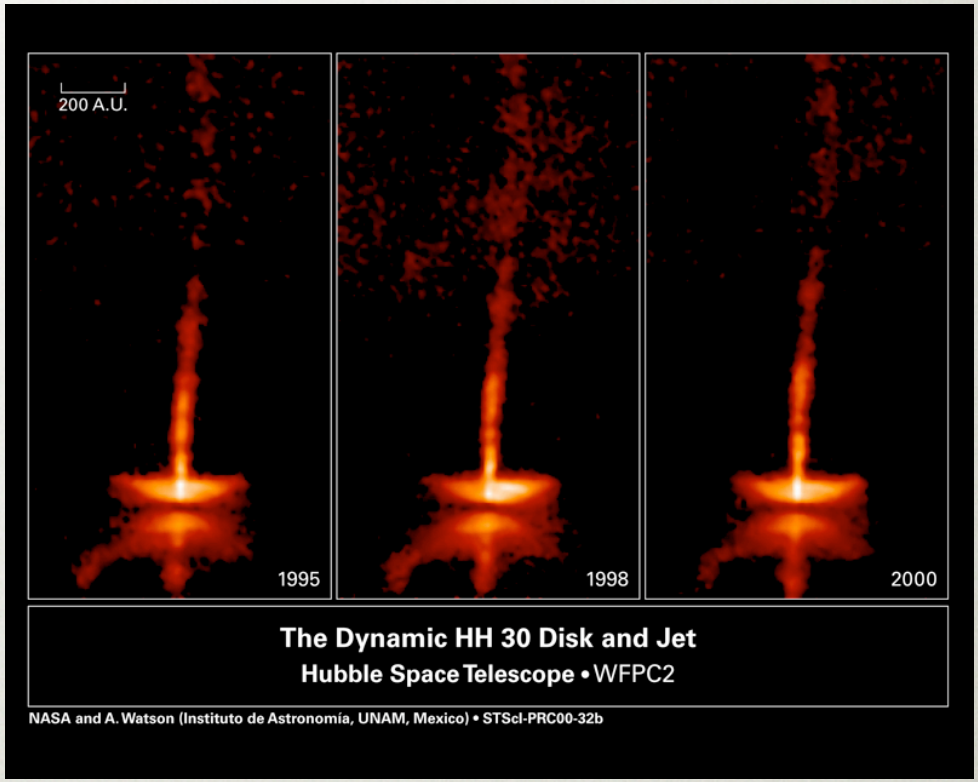
Circumstellar Disks

- Jets and Outflows

Launching of collimated jets and outflows from young star-disk systems have been widely observed in nearby star forming regions.

The expelled material contributes in the angular momentum removal process.

Our understanding of the launching mechanism and the the process that powers the outflows is still limited.



Circumstellar Disks

- Planet Formation

Circumstellar disks provide the material and the conditions for the formation of planetary systems.

Studying the structure, gas content and dynamics of inner disks we might understand the structural properties of planetary systems (masses, orbital radii and eccentricities).

— Gaseous planets
— Migration
— Time scales

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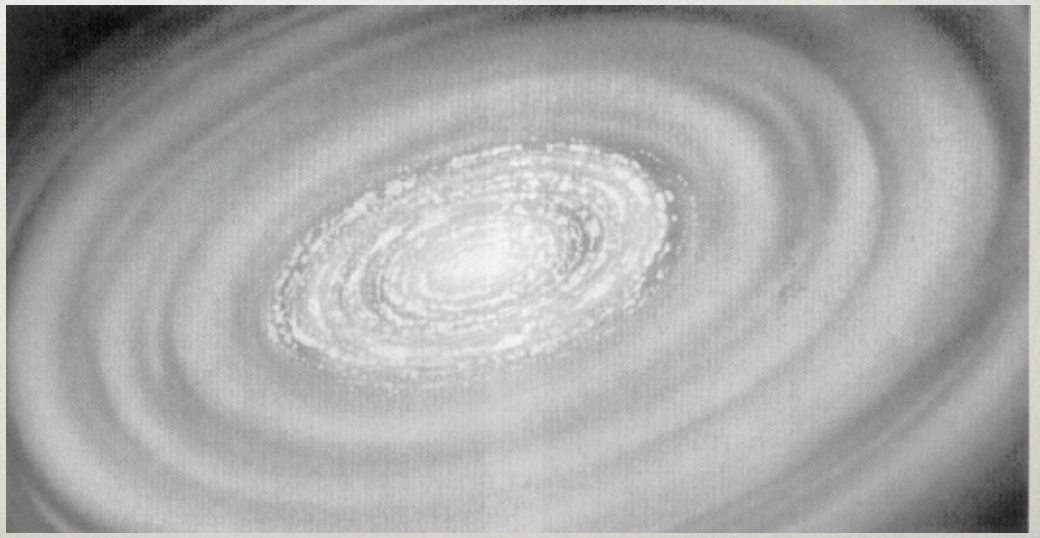

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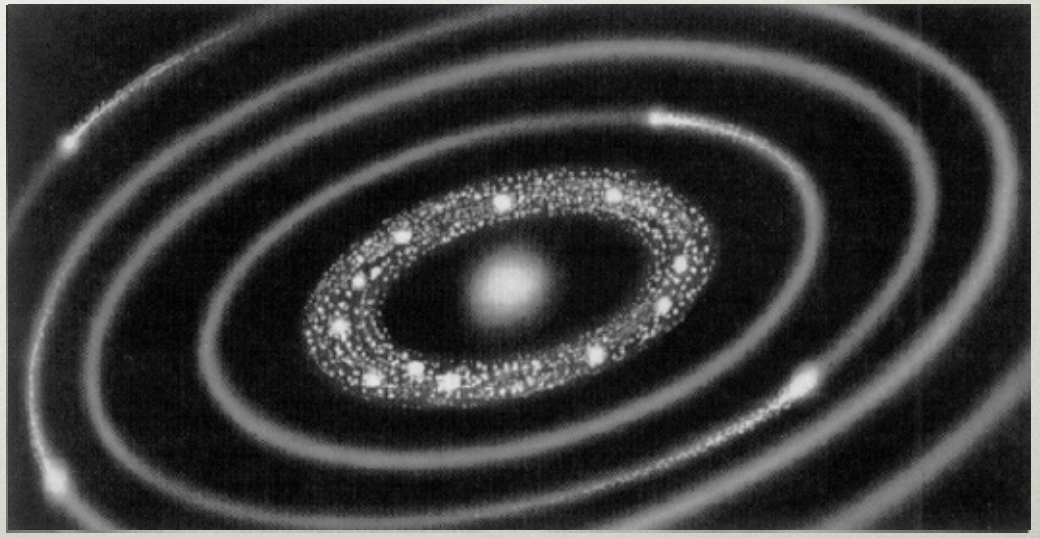

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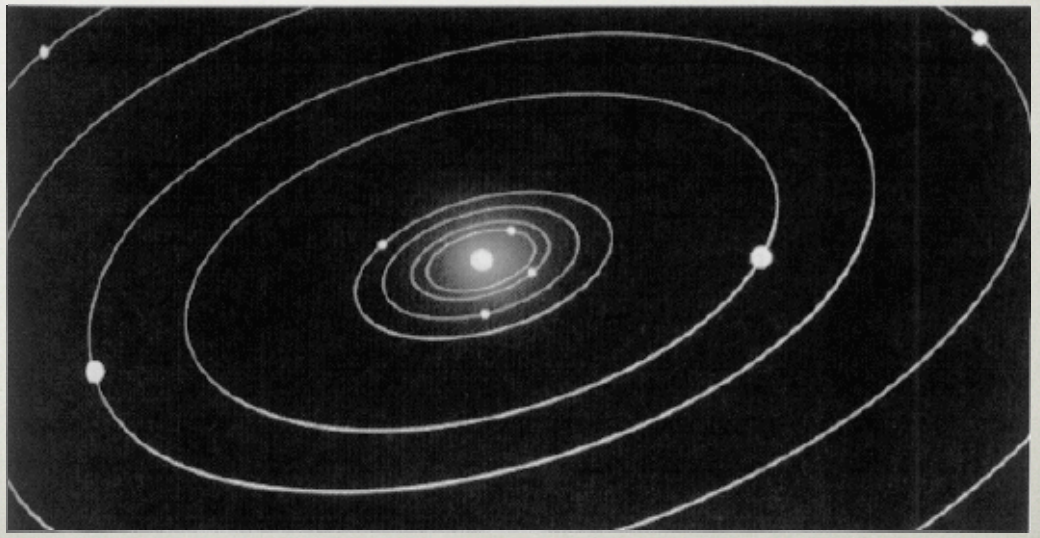
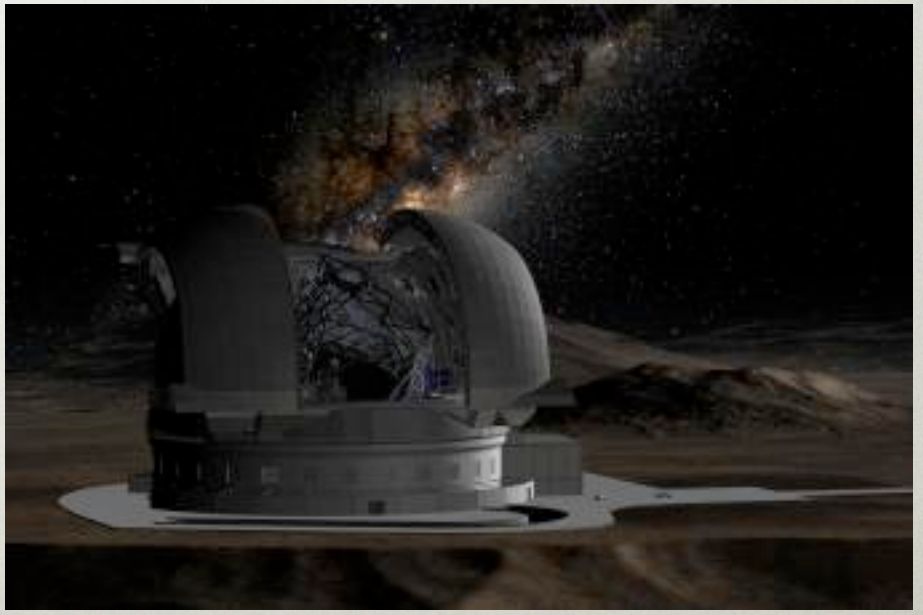


What to get from E-ELT

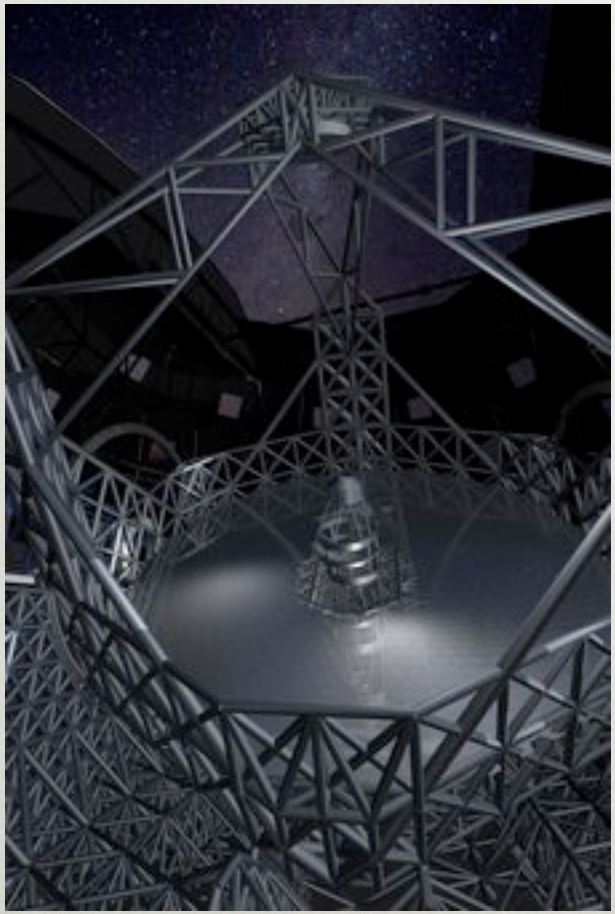
Broad range of questions to be addressed by E-ELT

- How is material funneled onto the star (magnetospheric accretion)?
- What is the impact of the central protostar on the disk?
- How are jets collimated and do they rotate?
- Can we understand the formation of planetary systems?



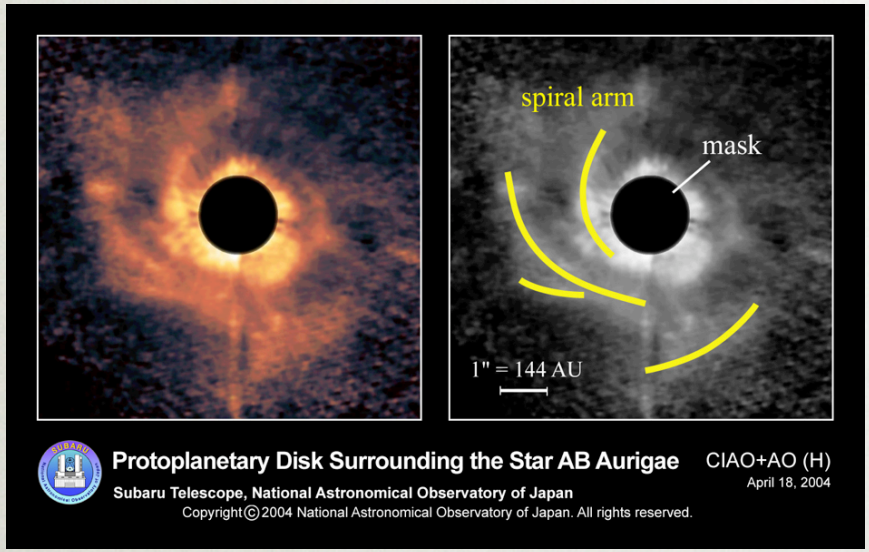
Particularly ...

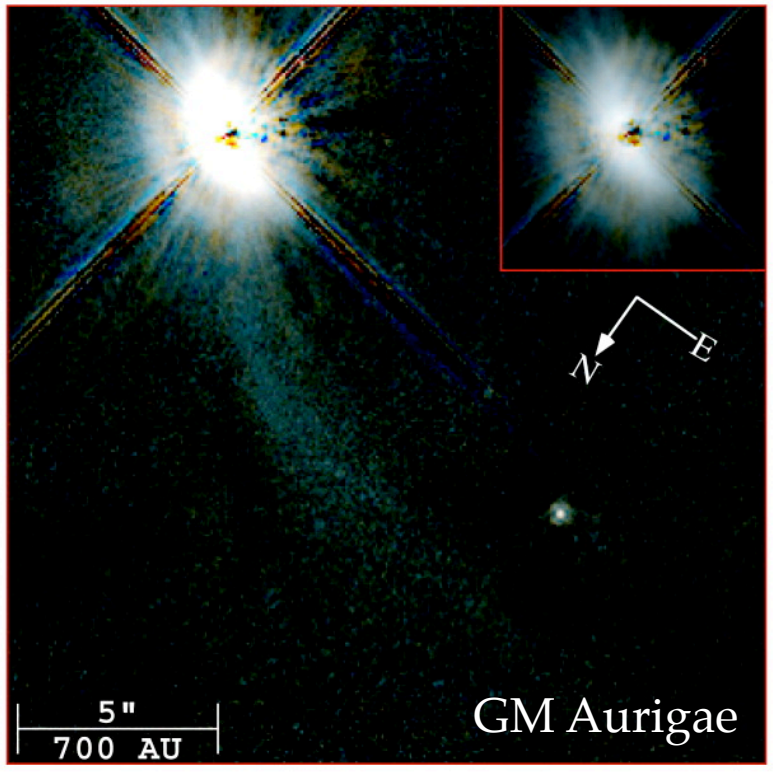
... a large, filled-aperture E-ELT provides key tools:



- Broad optical, near-IR, and mid-IR wavelength coverage
- High spatial resolution,
- High sensitivity for high resolution spectroscopy

On Planet Formation ...





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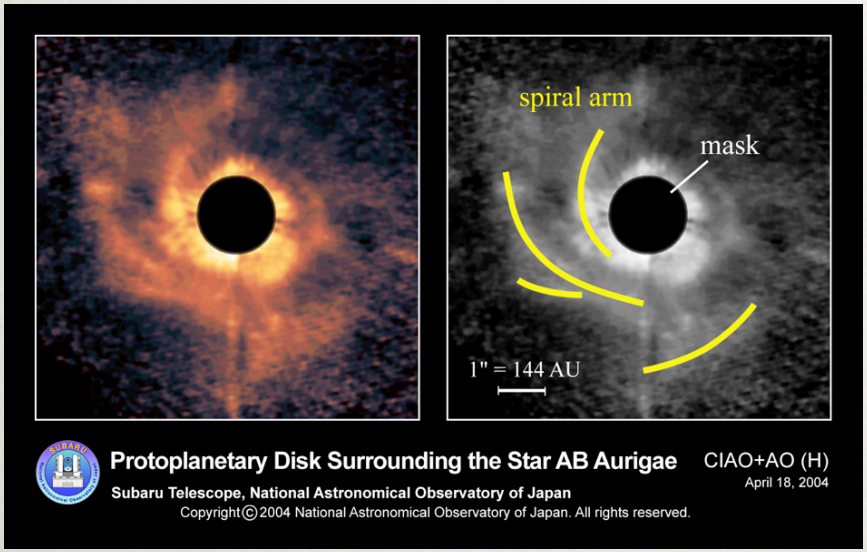
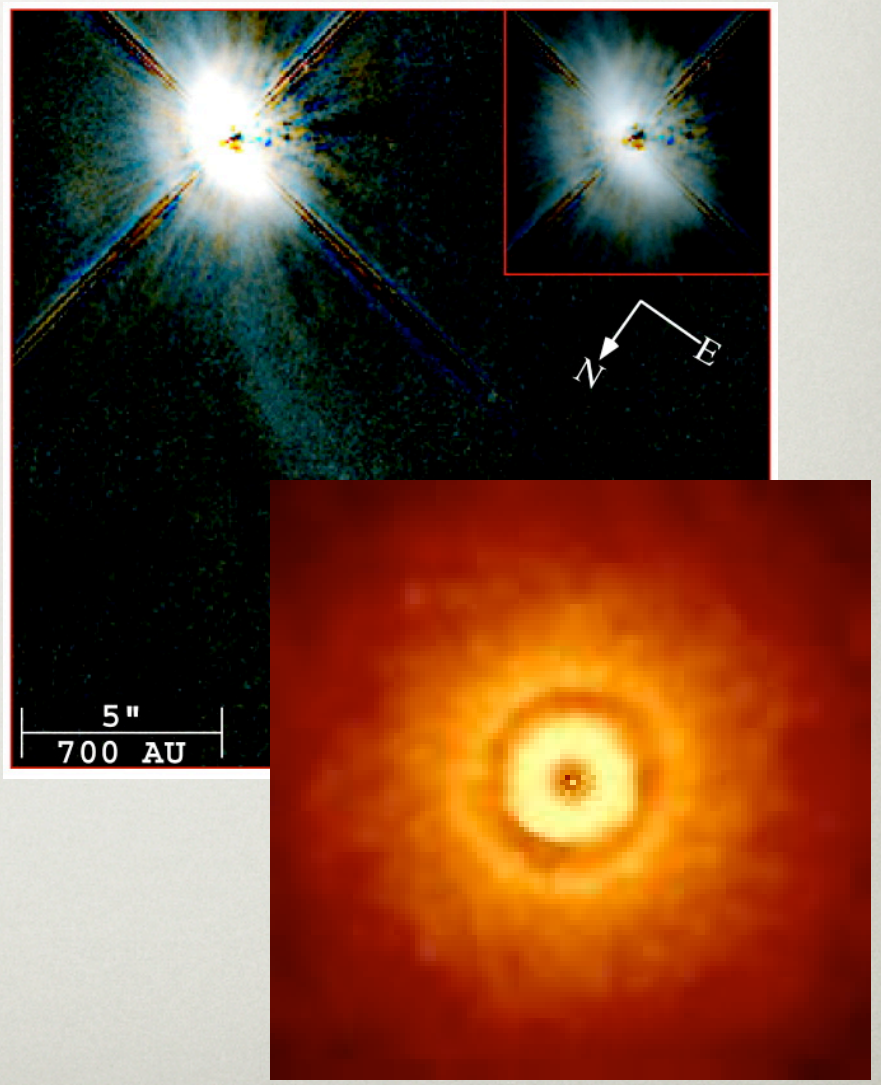




Science Case

- High spatial resolution imaging at 2-20μm
- Search for structures in disks indicative of ongoing or completed planet formation: gaps, rings, spiral density waves
- Young, optically-thick disks in star forming regions
- Diffraction-limited imaging
- Single object, small FOV

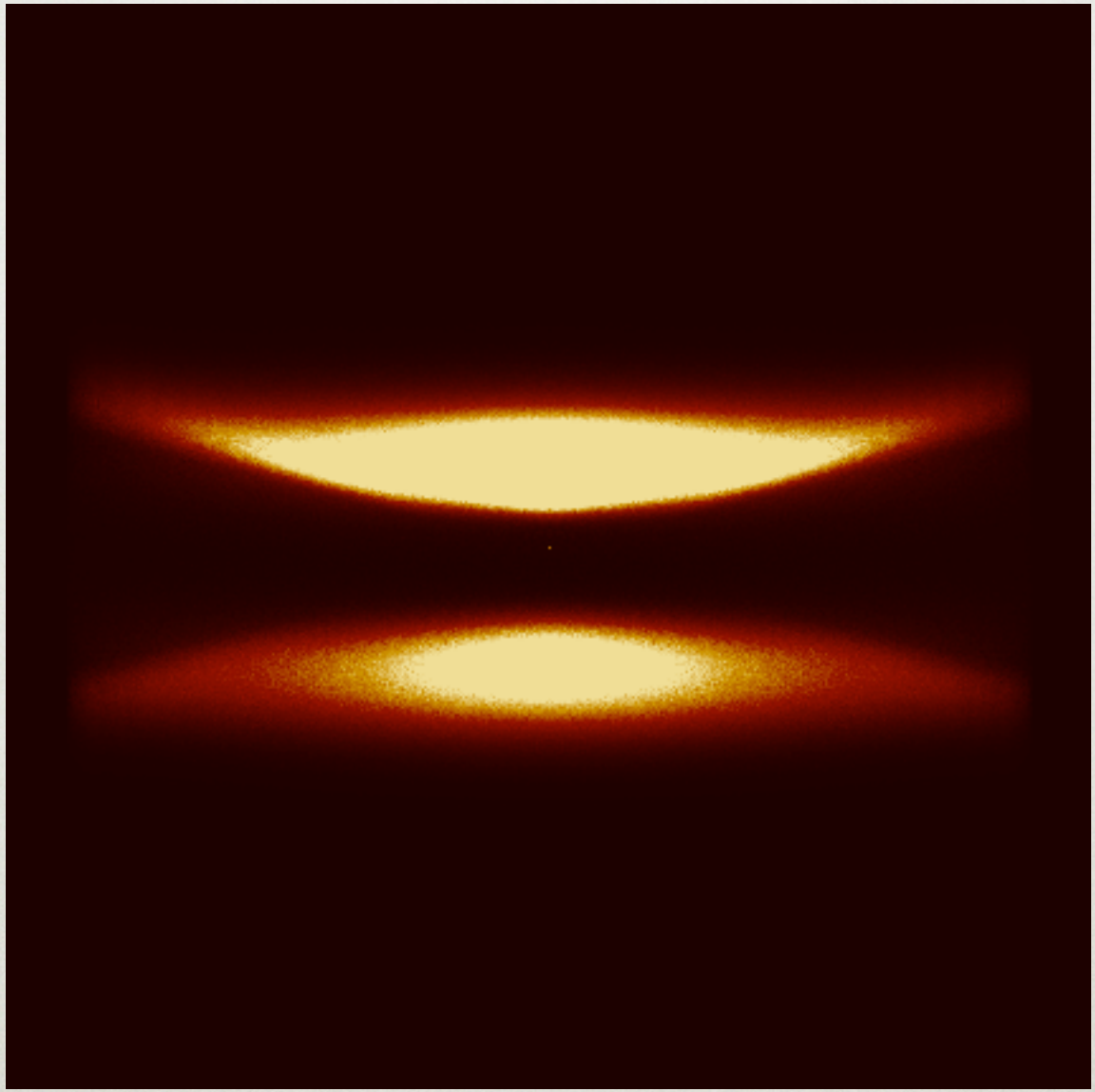
Goals of the simulations

- Trace the detectability of uniform disks as a function of distance to the observer
- Determine at which extent would planetary formation features be detected in a model case
  - TTauri star
  - $1 M_J$ planet
  - orbital radius of 5, 10 AU
  - gap width of 1AU
- Two characteristic distances:
  - 140 pc (Taurus)
  - 400 pc (~Orion)
- Include coronography in a realistic way

DISK MODEL

- MCFOST: 3D continuum radiative transfer code based in the Monte-Carlo method (Pinte et al. 2006)
- Simulations of a vertically isothermal, hydrostatic, non self-gravitating disk
- Homogeneous spherical dust grains with optical properties calculated with the Mie theory
- Synthetic images, SEDs and molecular emission maps
- Parametric gap with a gaussian distribution of particles

Credits: C. Pinte, Exeter University



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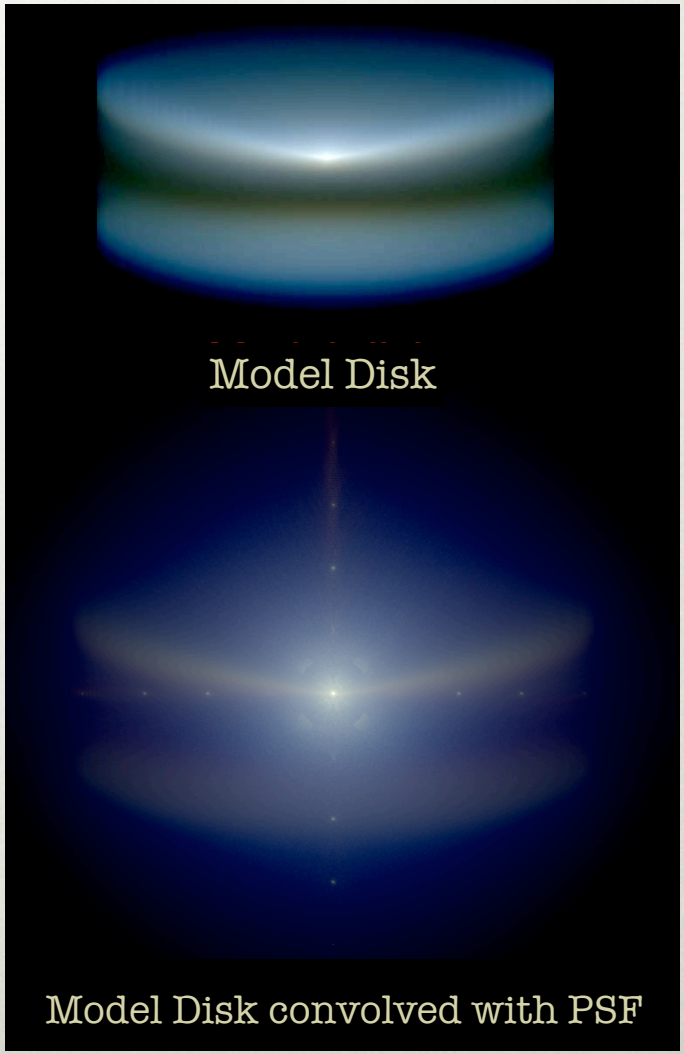
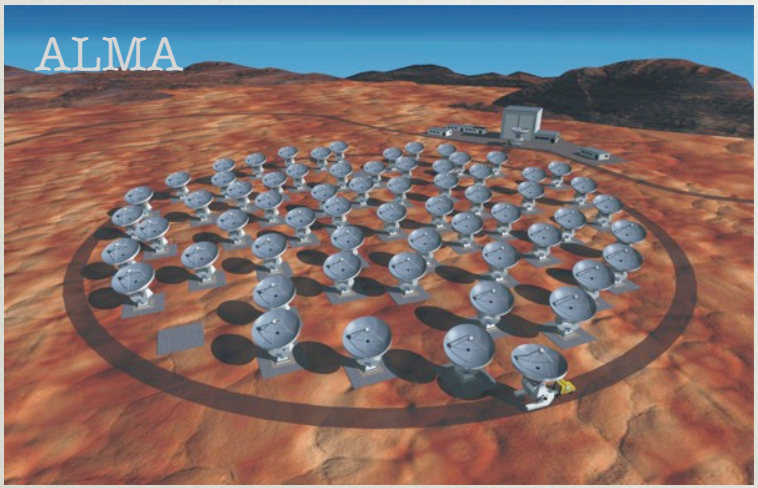
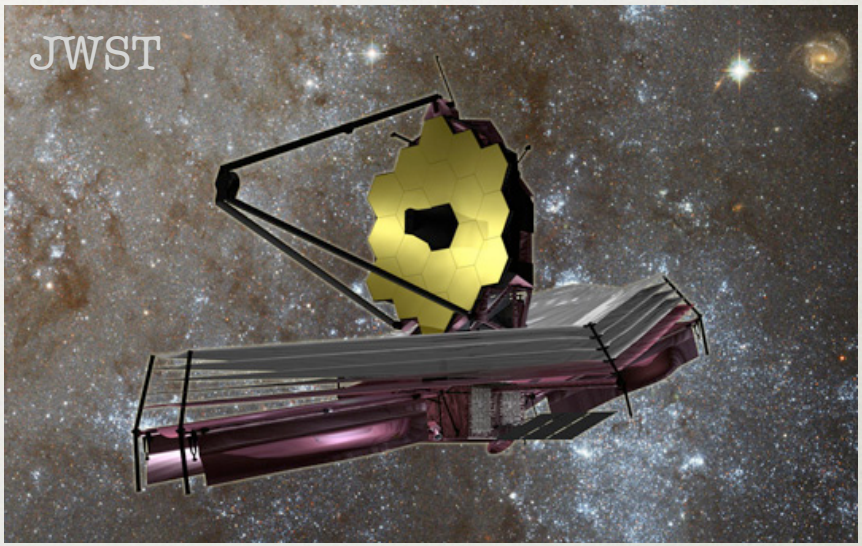
On-going simulations

- Simulated image convolved with an AO-corrected PSF
- Add sky and instrumental effects:
  - instrumental noise
  - efficiencies (mirror, optics, telescope)
  - telescope diameter
- Proceed afterwards with a standard analysis



Synergies





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