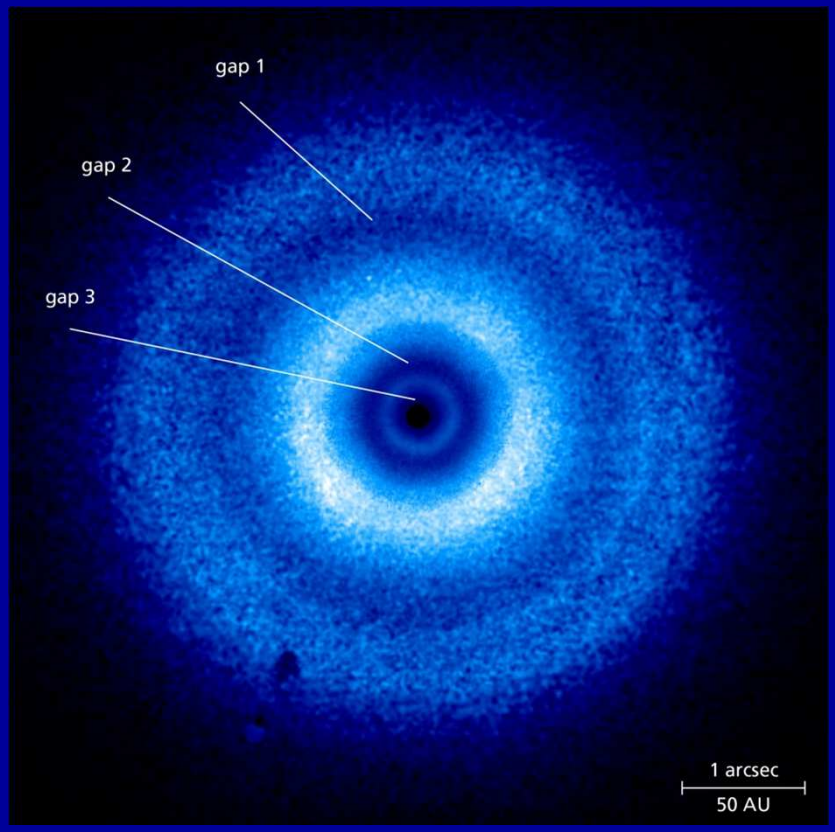
Perspektiven der Astronomie

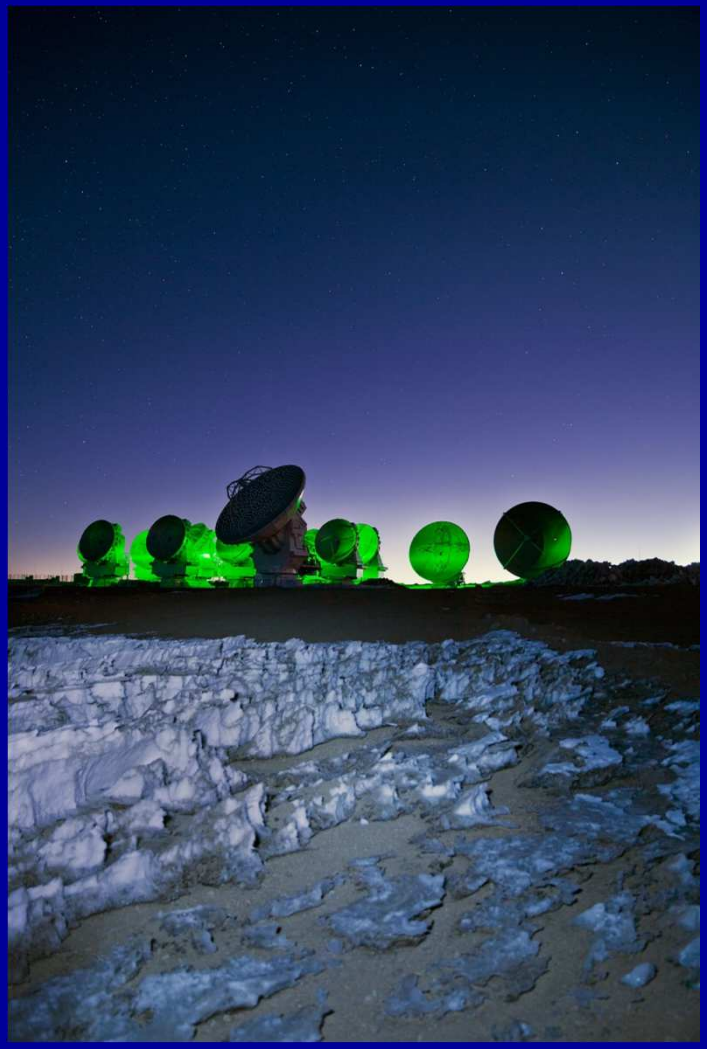
Thomas Henning
Max-Planck-Institut für Astronomie



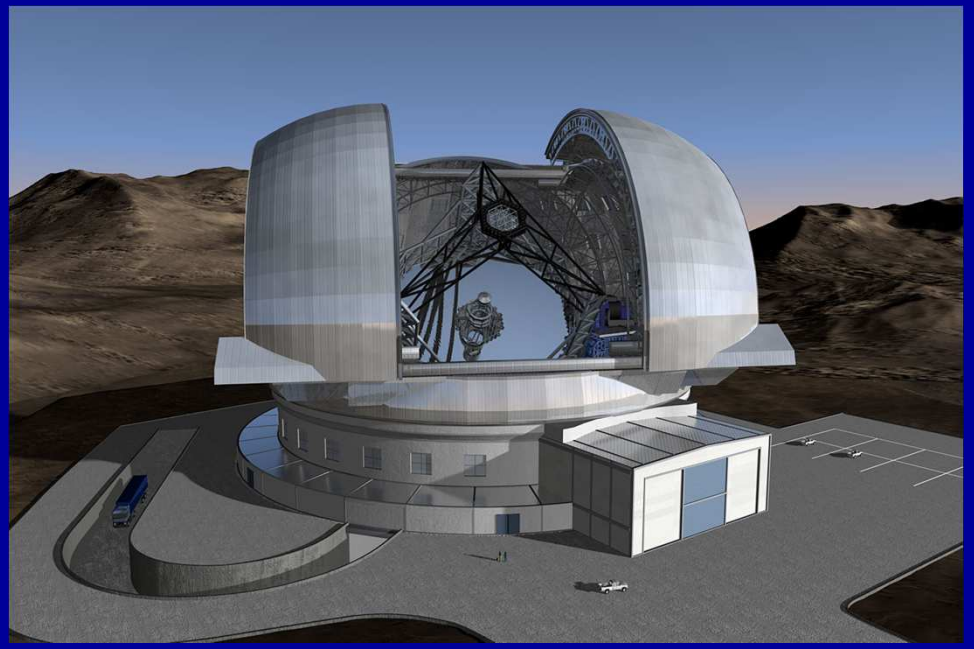
TW Hydrae Ringwelt

SPHERE/IRDIS @ H band mit apodized Lyot Koronagraph (40 marcsec – 2.4 a.u.)
van Boekel, Henning, Menu et al. (2017)

Landschaft in 2030

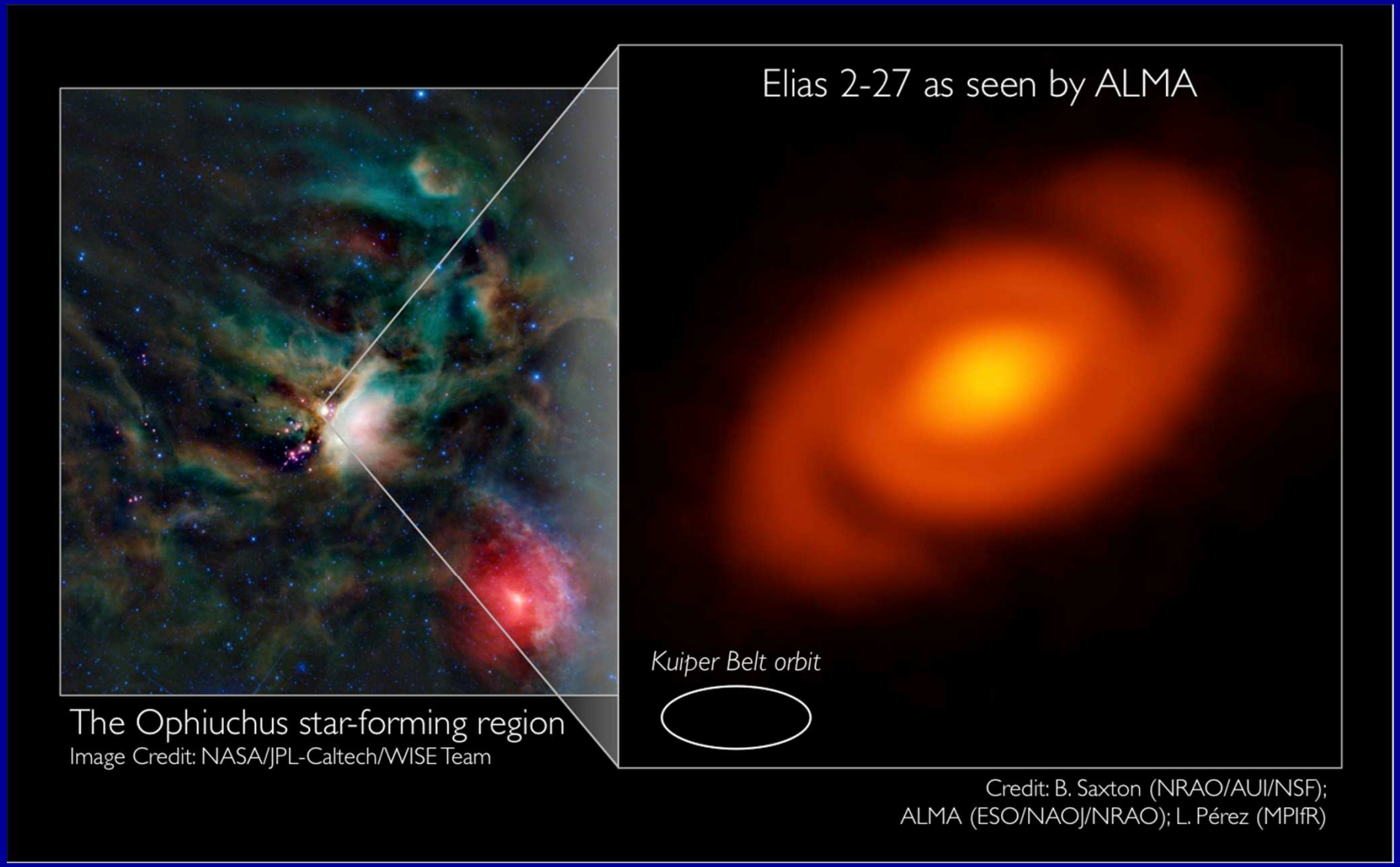


ALMA- Submm/mm
Imaging & Spektroskopie



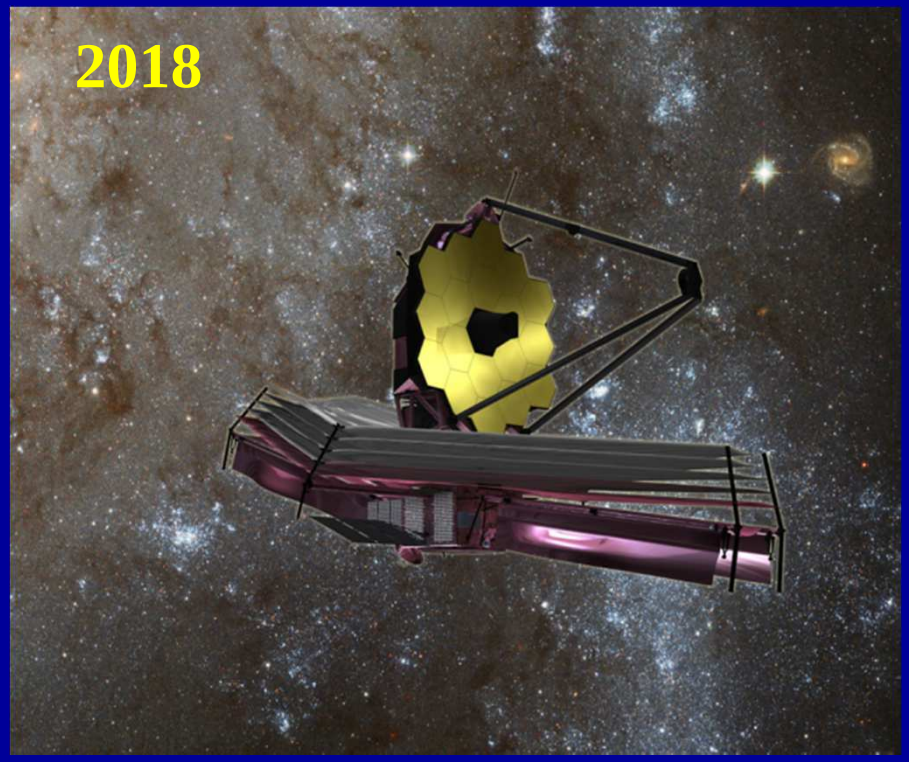
ELTs – Vis-20 µm
AO-unterstütztes Imaging &
Spektroskopie

Von Scheibenstrukturen zur Diversität von Planeten

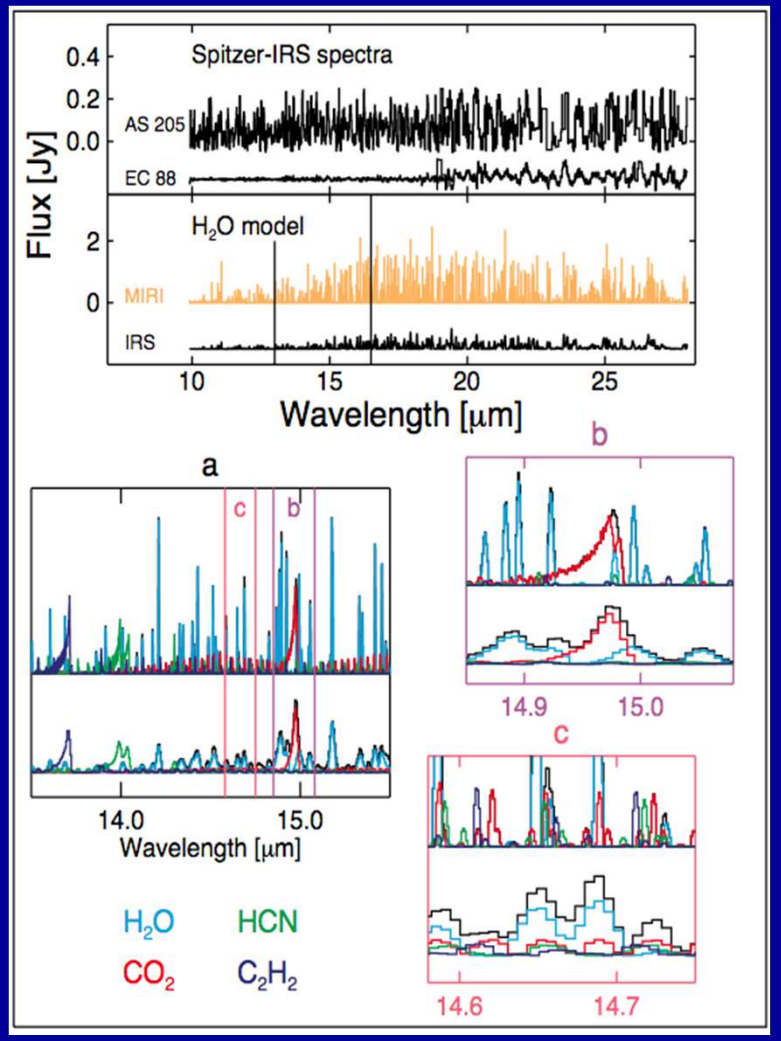


Perez et al. (2016)

2030 – 10 Jahre JWST



James Webb Space Telescope
& WFIRST



Denkschrift Astronomie - 2017

- ELT
- Instrumente für La Silla/Paranal-Observatorium, ALMA
- SKA
- Weiterentwicklung von LBT, NOEMA, LOFAR

- Weltraum – Cosmic Vision Program
- Nationales Programm - SOFIA und eRosita

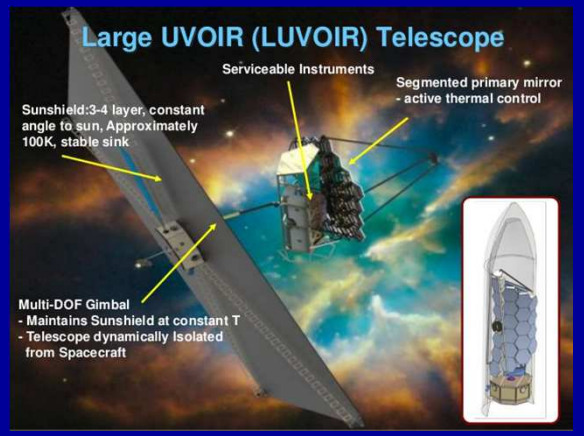
2020 Decadal Review in den USA …

- LUVOIR (UV-optisches-IR-Teleskop)
- HAbEx (Habitable Exoplanet Mission)
  (4-6,5 m-Teleskop – 250nm-1,8 µm für High Contrast Imaging, Starshade)
- Origins Space Telescope
  (8-15 m-Teleskop, Aktiv gekühlt, 5 $\mu m - 1 mm$
- Lynx
  (Röntgemission, 0.5“-Auflösung, Spektroskopie)

Was ist LUVOIR?

Large UV / Optical / Infrared Surveyor (LUVOIR) –

Teleskopkonzept in Tradition von Hubble



Breite wissenschaftliche Möglichkeiten

Fernes UV bis Nahes IR

~ 8 – 16 m Spiegeldurchmesser (A – 15 m & B – 9m)

Imager & Spectrographen

Service Missions und Weiterentwicklung möglich

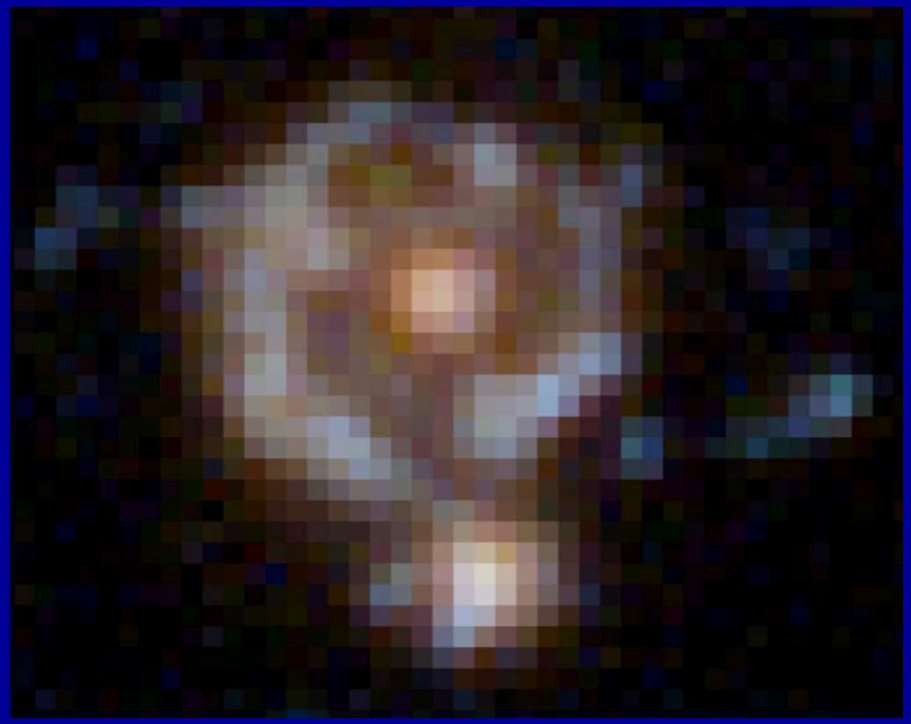
Gastbeobachterprogramm wie bei Hubble

3 Hauptinstrumente

- Optischer/NIR Koronograph (bis zu Faktor 10^{-10} Unterdrückung)
- Multiobjekt UV-Spektrograph (100-400 nm) (R=500 -45.000)
- Imager (2x3 arcmin) – 0,2 to 2,5 µm
- Optischer/NIR-Spektrograph (verschiedene spektrale Auflösung bis 10^5)

HST STIS UV instrument

Astronomie mit LUVOIR …

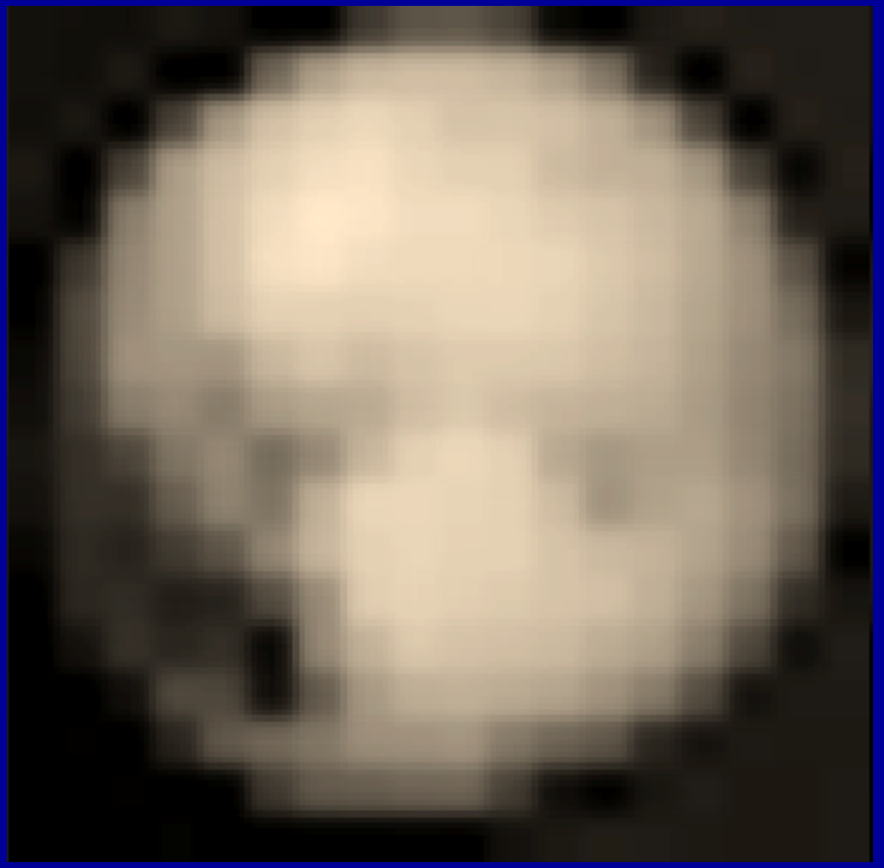


Galaxy at z = 2
with HST

Galaxy at z = 2
with 12-m LUVOIR

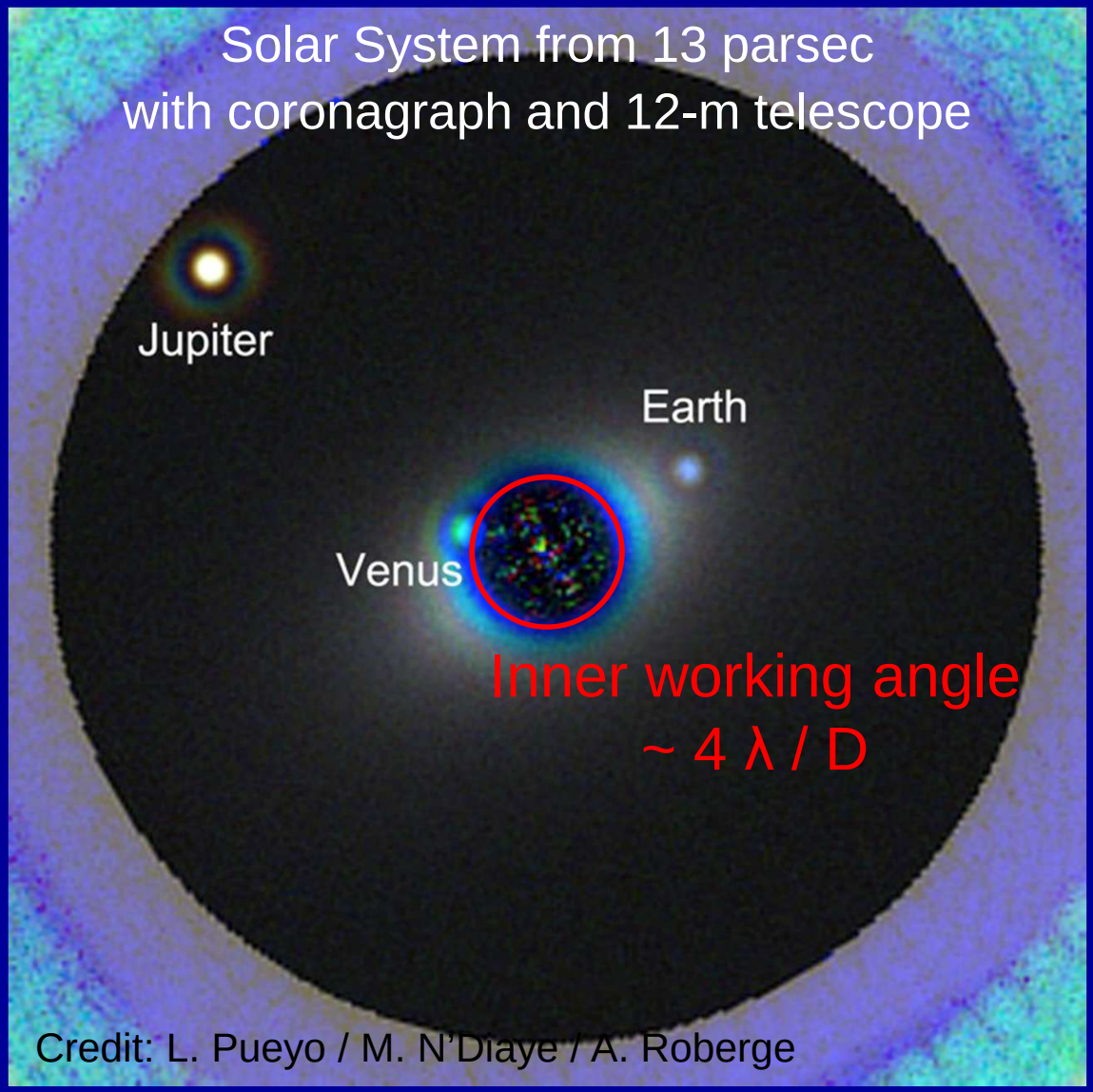
Imagine Astronomy with LUVOIR . . .

Pluto with HST

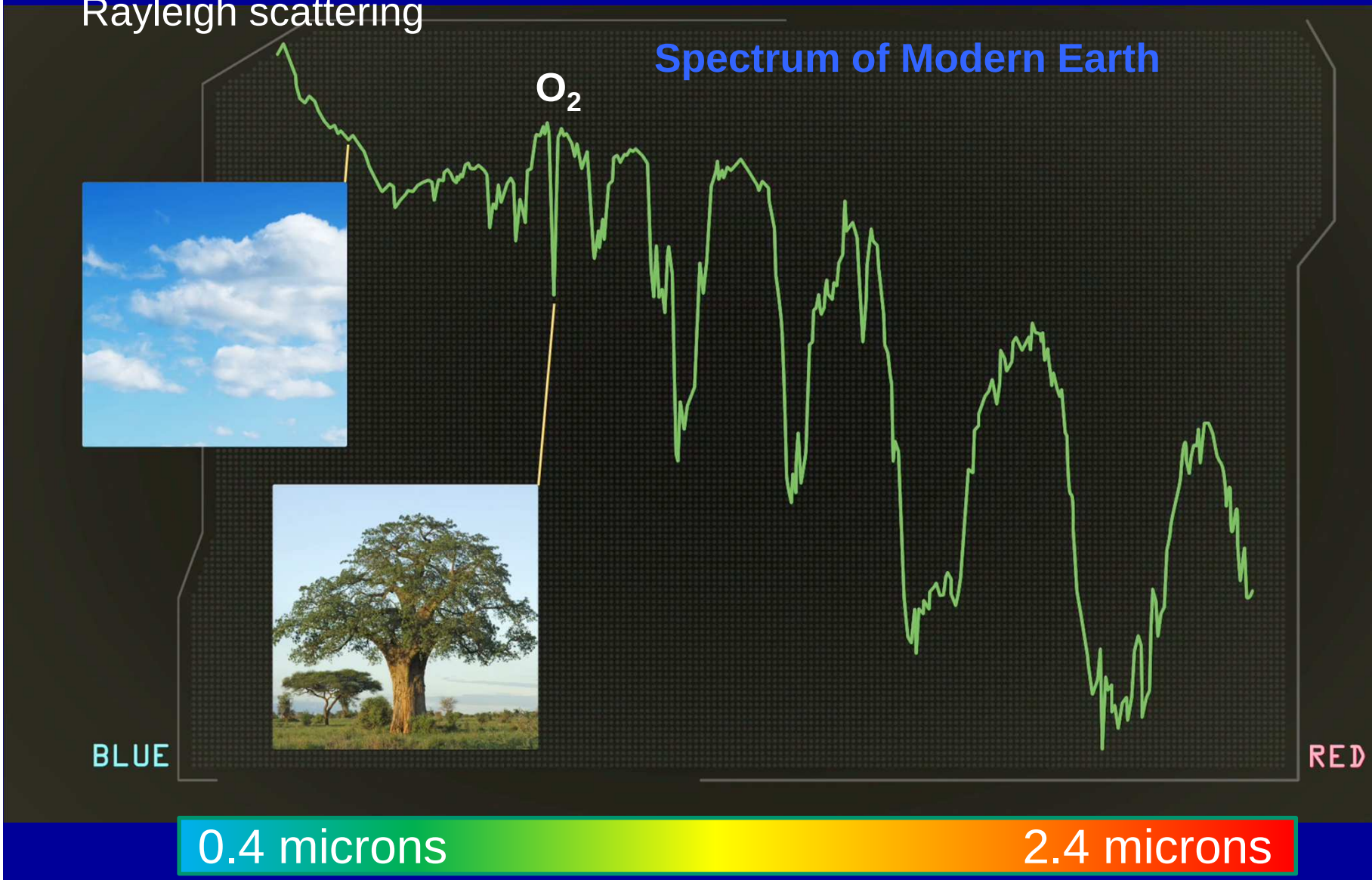


Pluto with 15-m LUVOIR

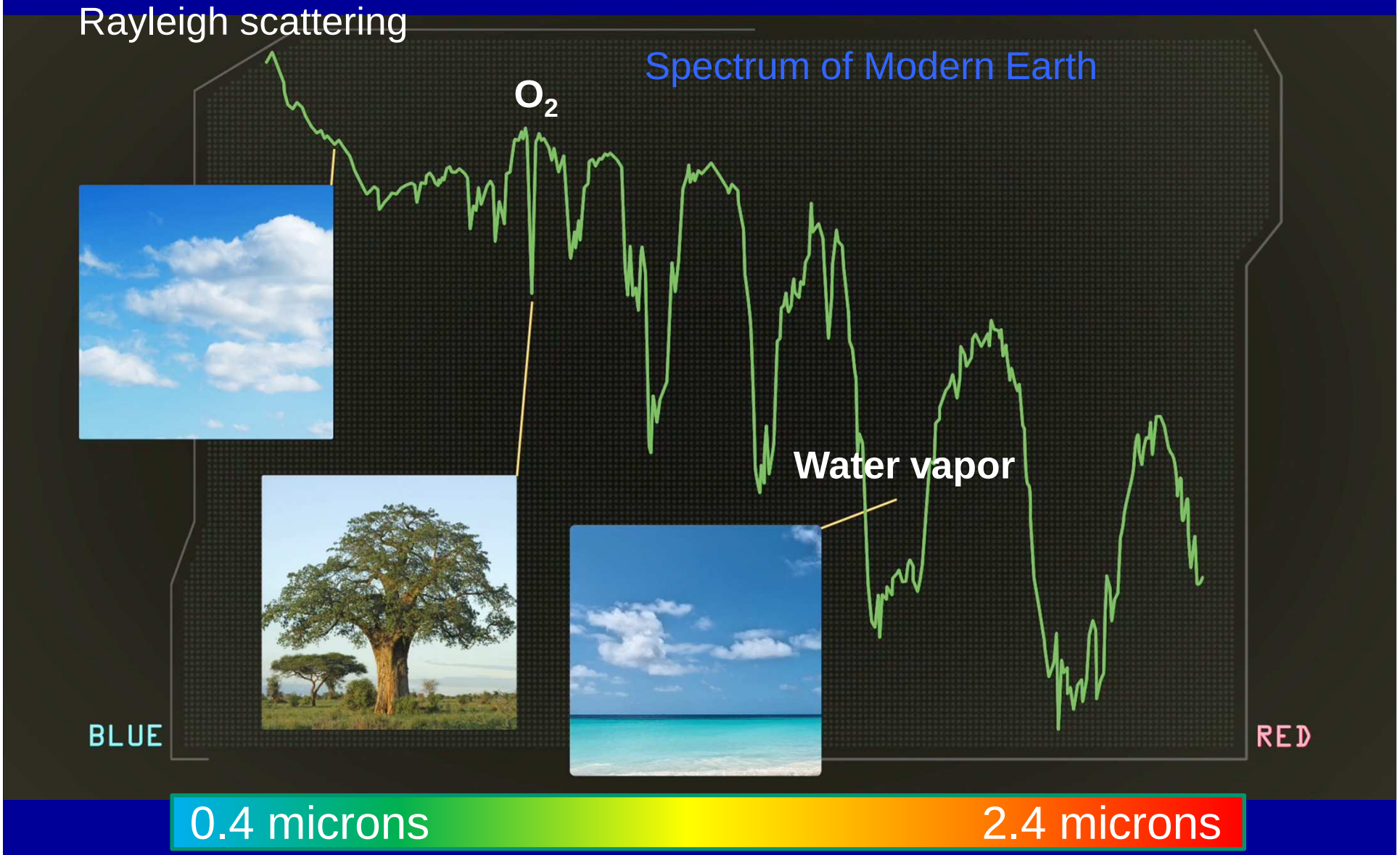
Imaging Earth 2.0



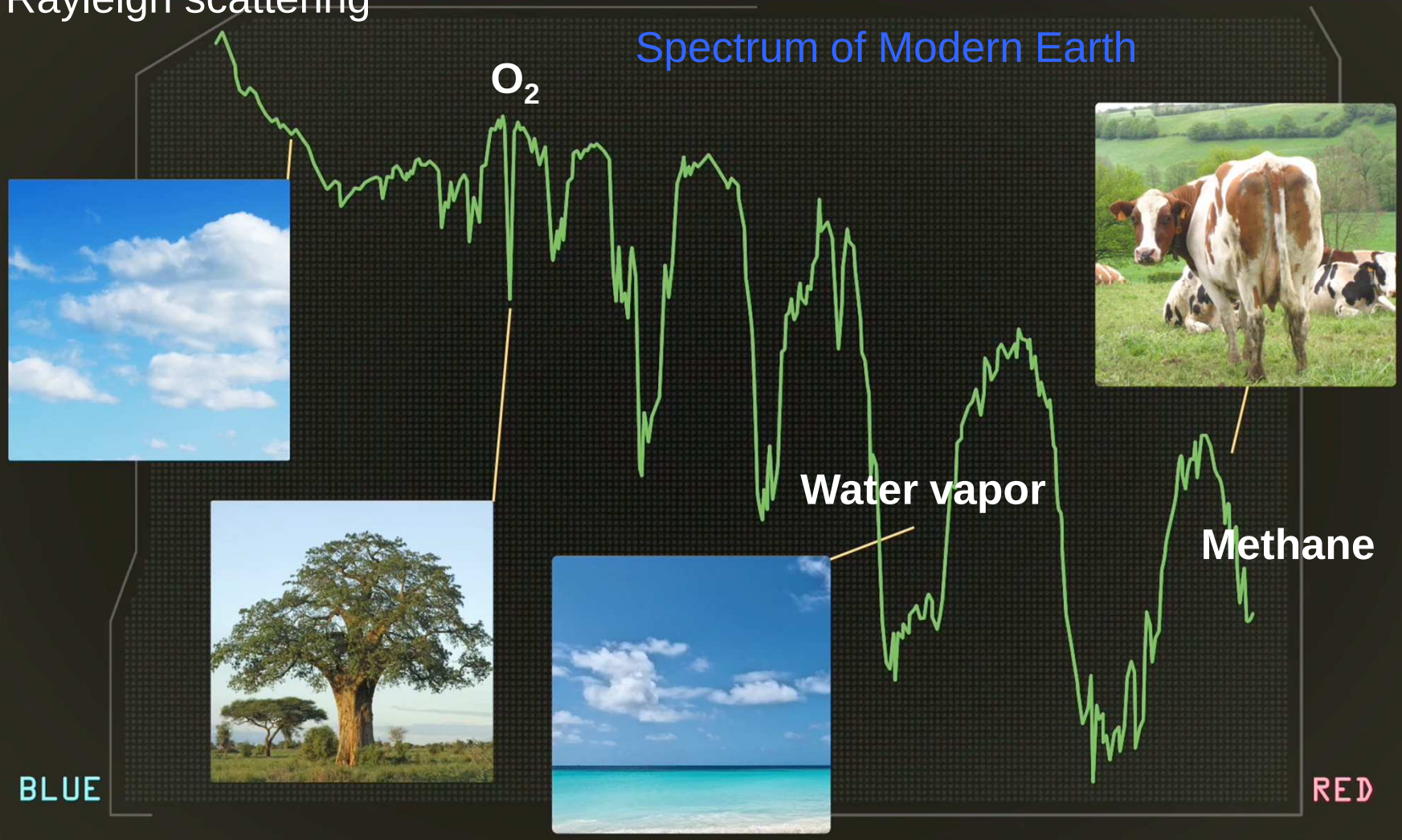
The search for life – biosignatures



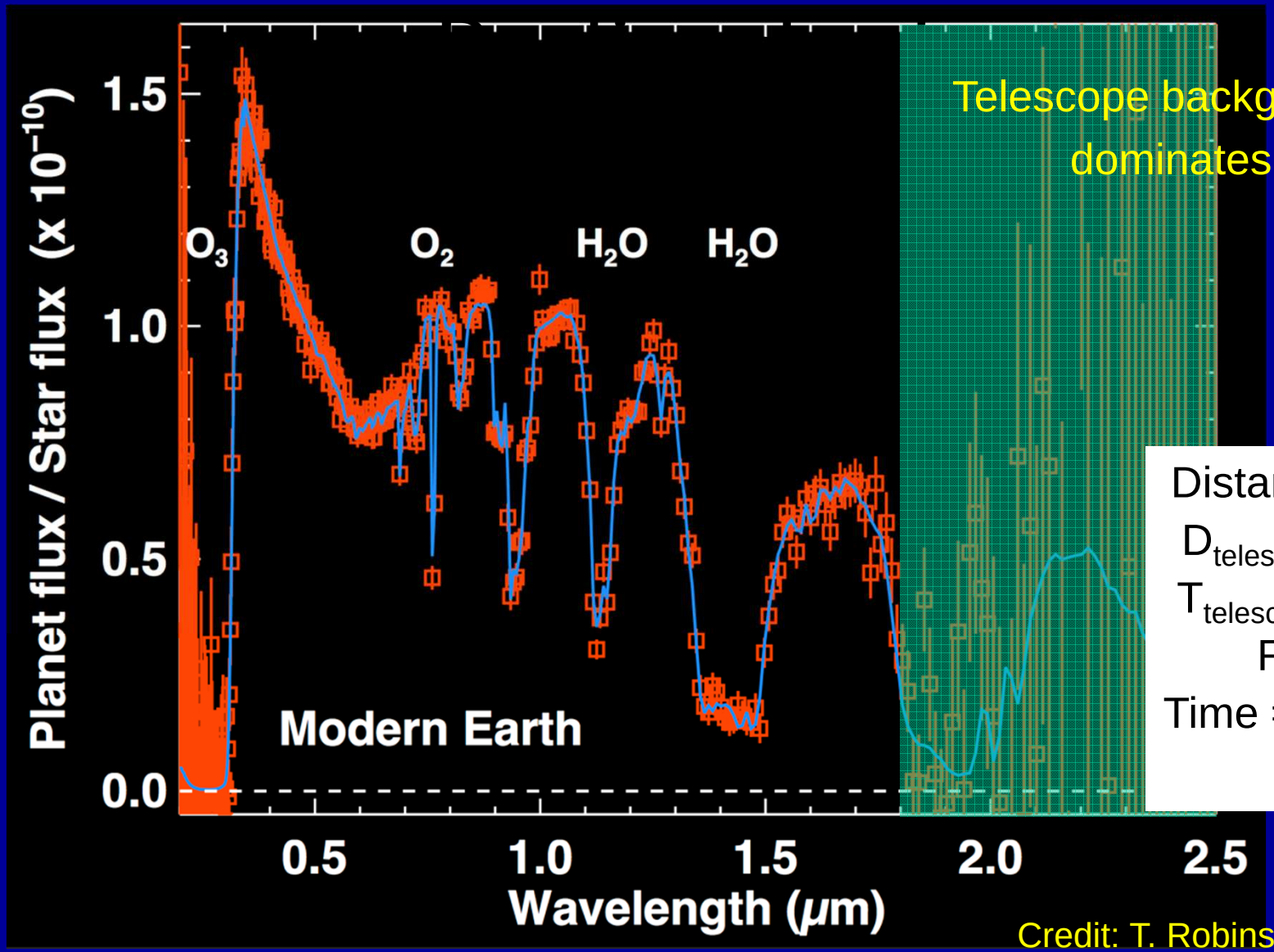
The search for life – biosignatures



The search for life – biosignatures



Reality Check



Telescope background dominates

Distance = 10 pc

$D_{telescope}$ = 12-m

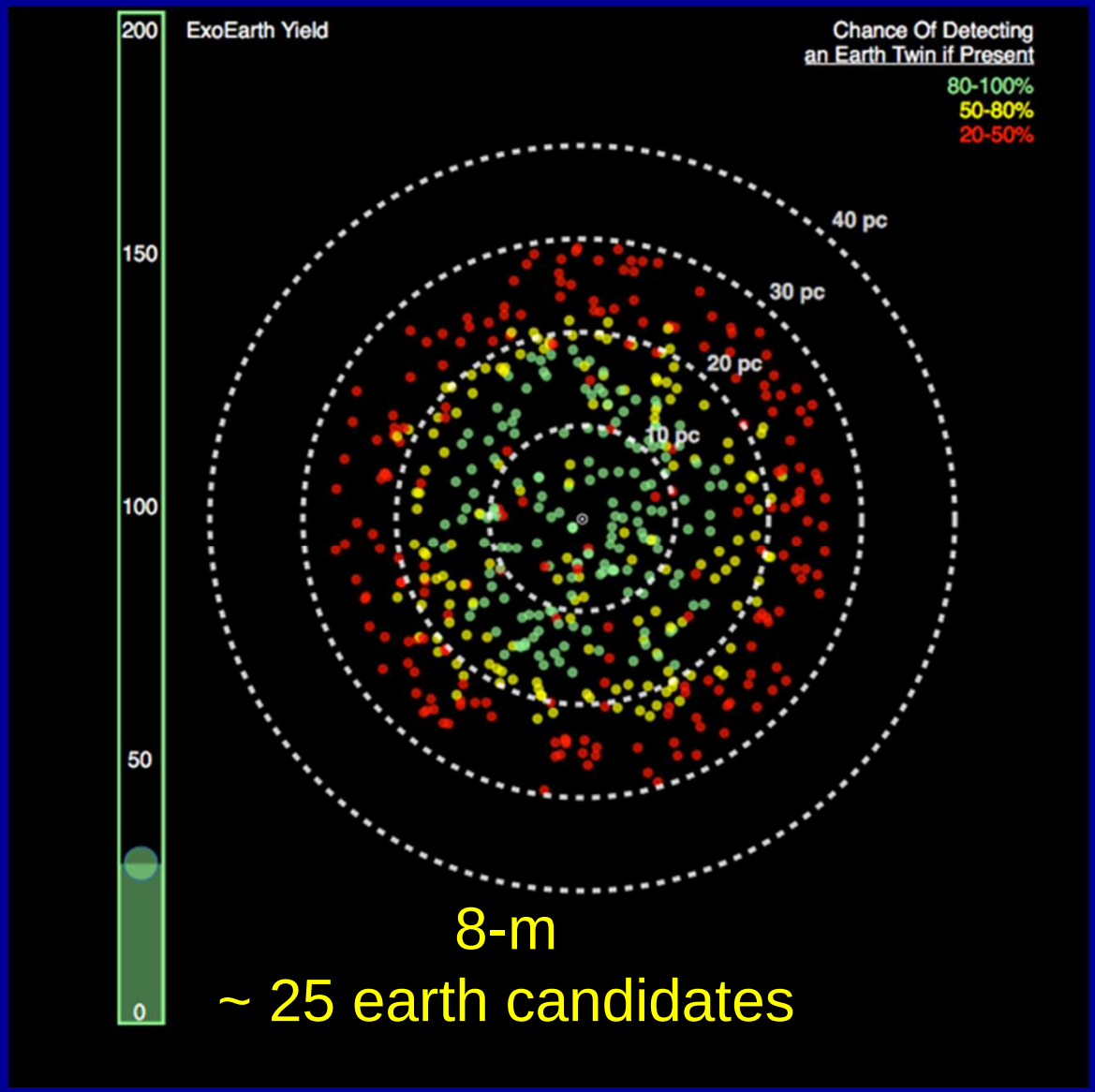
$T_{telescope}$ = 260 K

R = 150

Time = 96 hrs per band

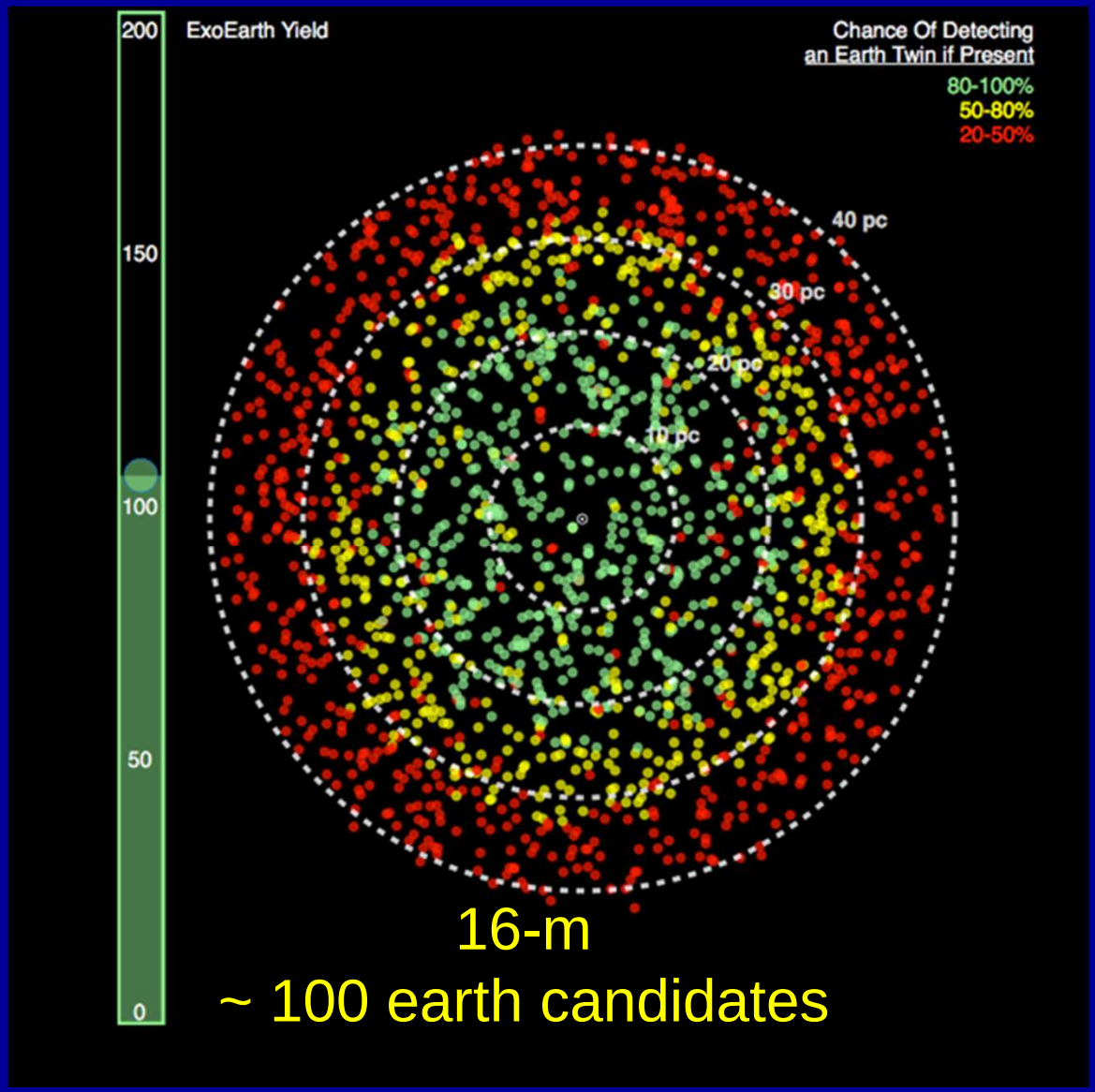
Credit: T. Robinson / G. Arney

ExoEarth candidates as function of aperture



Stark et al. (2014)

ExoEarth candidates as function of aperture

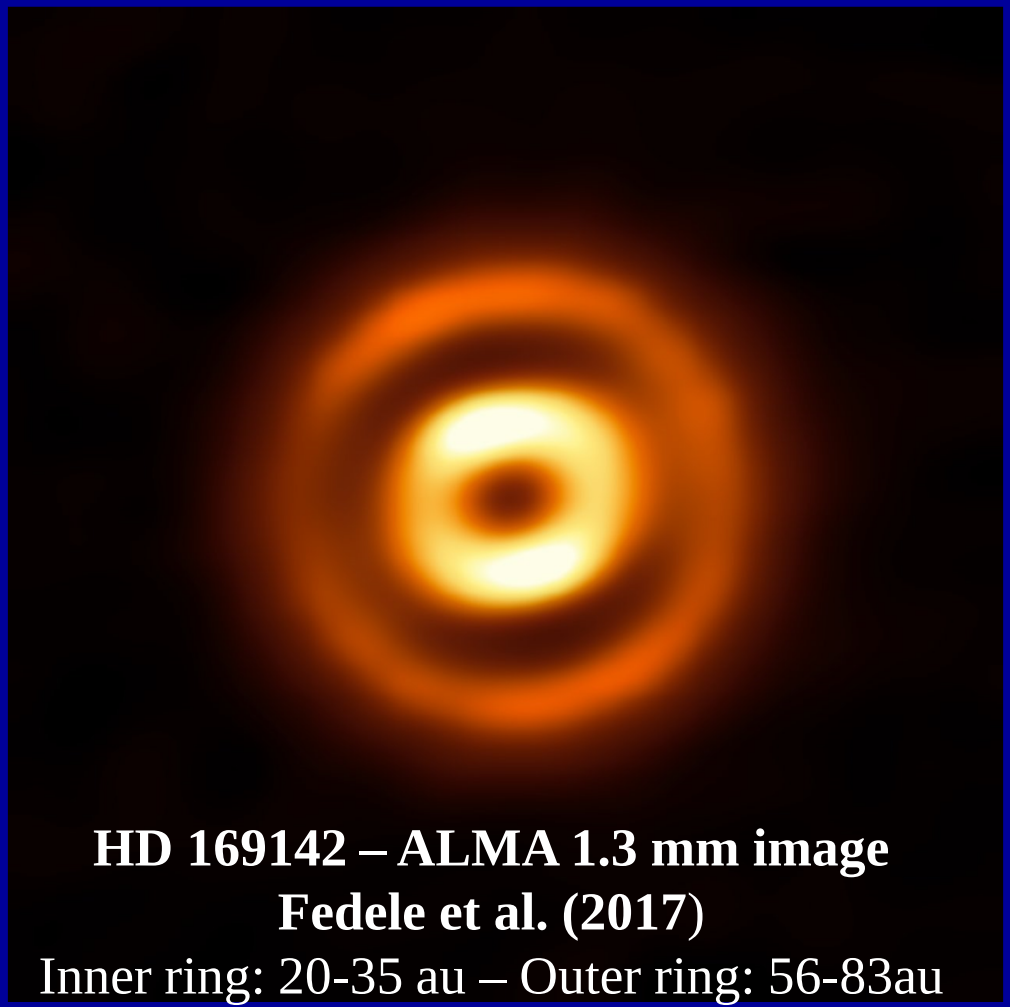


16-m
~ 100 earth candidates

Stark et al. (2014)

Planeten in Scheiben

Niedrige Masse – Kleine Strukturen – Line/Kontinuum klein
Empfindlichkeit – Winkelauflösung – Hohe spektrale Auflösung

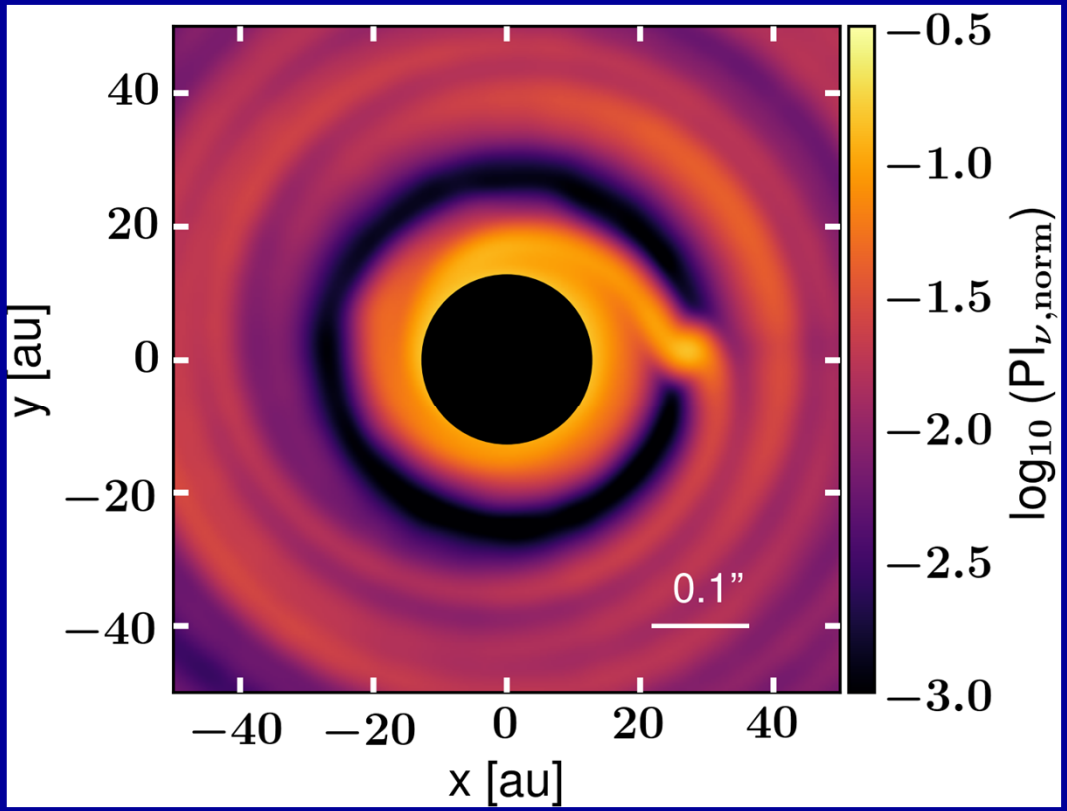


HD 169142 – ALMA 1.3 mm image
Fedele et al. (2017)
Inner ring: 20-35 au – Outer ring: 56-83au

LUVOIR Imaging

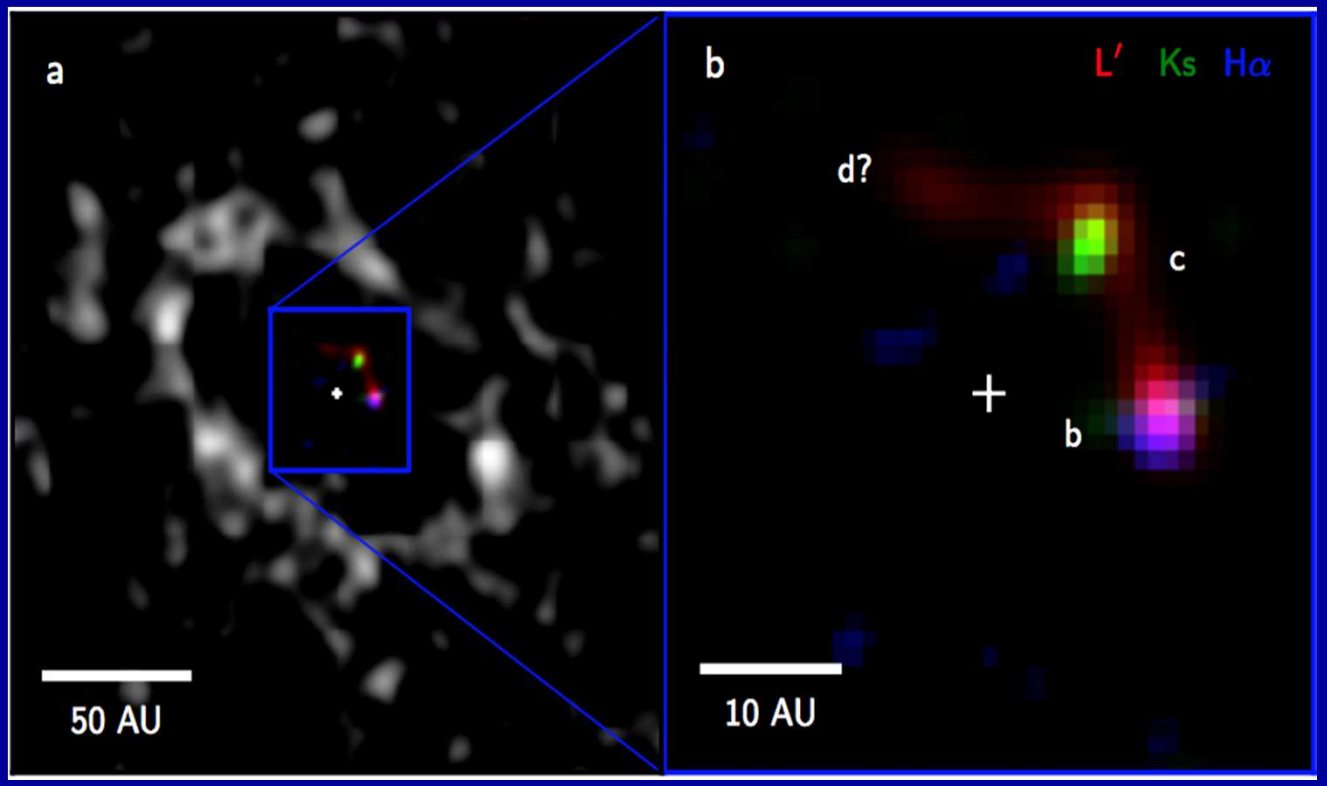
High-contrast optical imaging - Inner disk structures

IWA @ 600 nm = 2 λ / D ≈ 15 to 30 mas = 2 to 4 AU @ d = 140 pc



PI Image (inner 0.2´´ has been masked) –
Convolved with Gaussian PSF with FWHM = 20 mas
(MPIA Simulation after Pohl et al. 2015)

Suche nach eingebetteten Planeten - LkCa 15

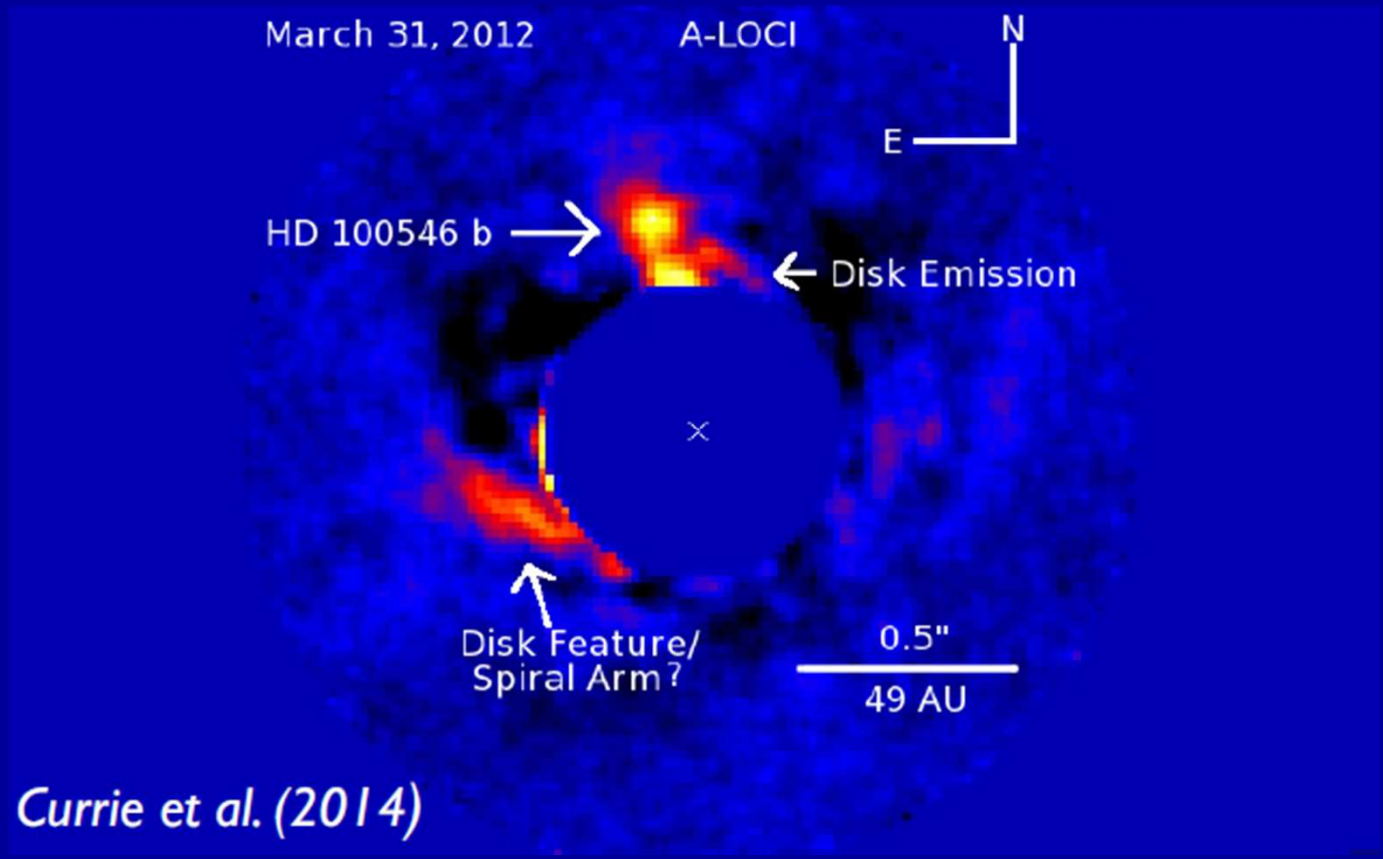


VLA Mm Observation of Disk

Hα (blue), Ks (green), L`(red)
Sallum et al. (2015)

Accretion rate = 5 x 10^{-10} Msun/yr : Planet/Star contrast for Jovian-mass planet is 10^{-4}
(with extinction up to a factor 100 smaller)
MagAO: 10^{-4} at 200 mas; Needed: 10^{-6} at 10 marcsec (20 marcsec)

Planeten in Protoplanetaren Scheiben



Inner Planet Candidate: 20-30 M_J @ 10 AU (Mulders et al. 2013, MIDI/VLTI, See also Acke & van den Ancker 2006, Tatulli et al. 2011, Brittain et al. 2014)

Outer Planet Candidate: 15 M_J @ 70 AU (Quanz et al. 2013, 2015, Currie et al. 2014, but Rameau et al. 2017)

Technologische Herausforderungen

- Kompatibilität zwischen UV & Koronagraphie
- Extrem hoher Kontrast mit segmentierten Teleskop
- Lichtwegkontrolle auf einem neuen Niveau
- Optische und Infrarotdetektoren mit sehr geringen Rauschen
- Effiziente Telekopbetreibung für vernünftiges Sample

Technologische Entwicklungen
Entfaltung eines segmentierten Teleskops

Credit: A. Jones (GSFC)

LUVOIR