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WOPA
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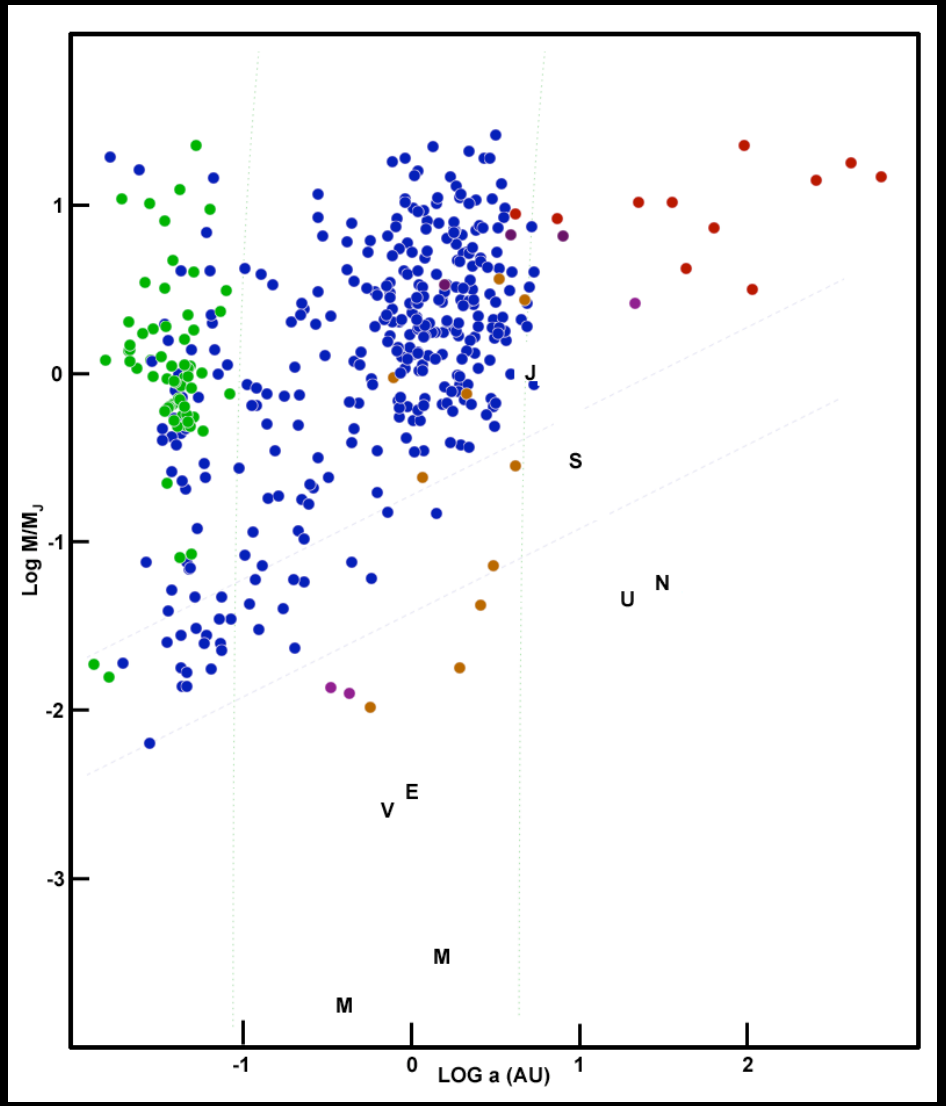
Opportunities for Astrophysical Observations of Radiation Hydrodynamics

Exoplanets

424 Planets

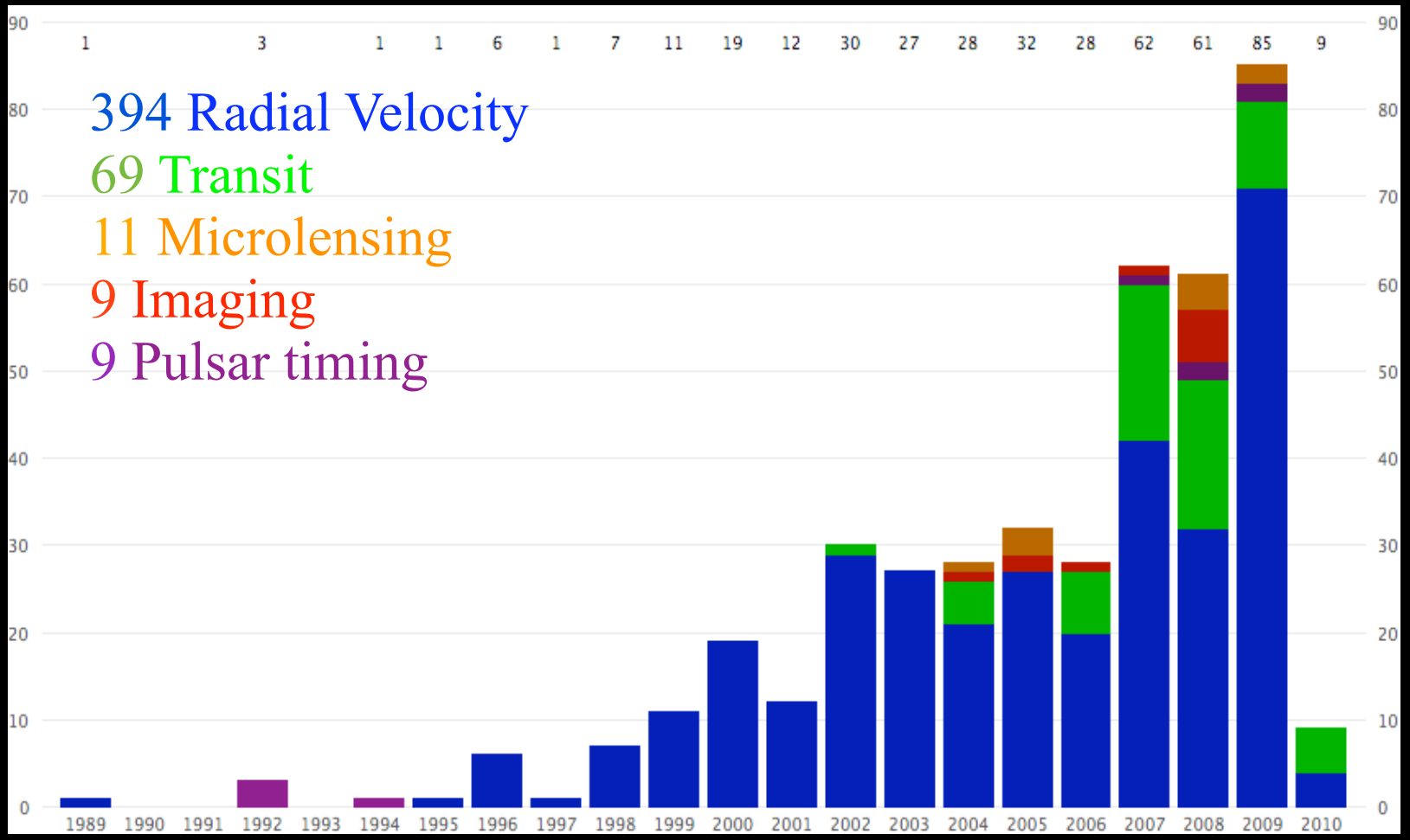
394 Radial Velocity
69 Transit
11 Microlensing
9 Imaging
9 Pulsar timing

Many Hot Irradiated Planets



Exoplanets

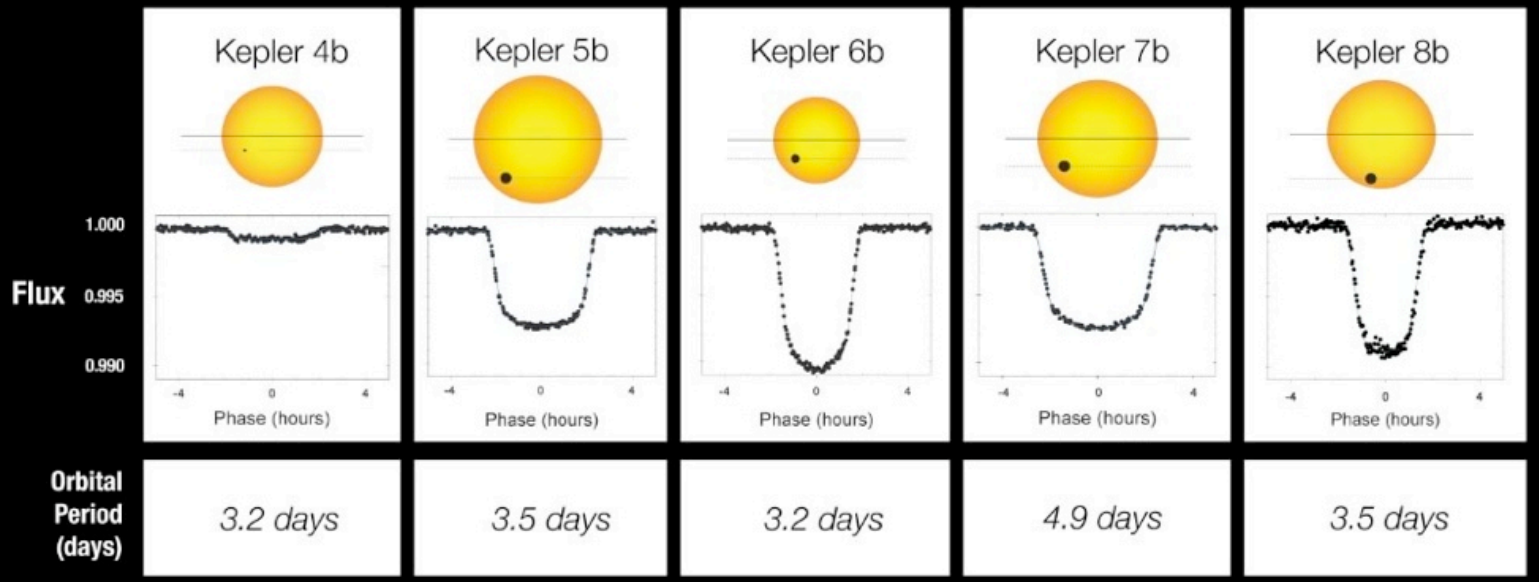
- Discovery rate increasing
- Here come the transits!



Exoplanets

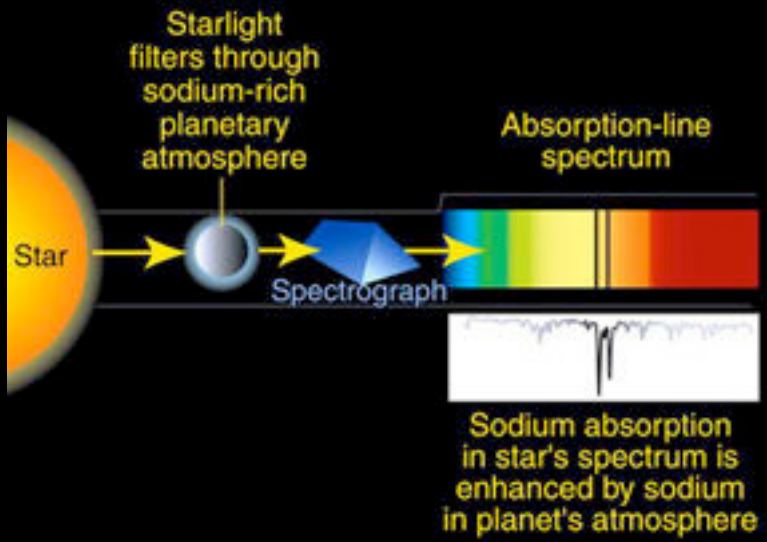
- KEPLER first results coming in
- Earthlike planets coming
- Huge statistical base

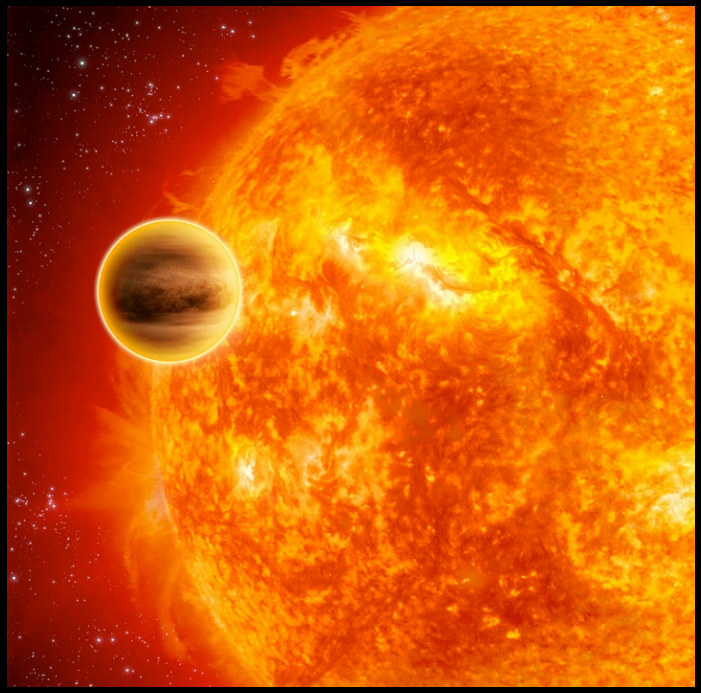
Transit Light Curves



Exoplanets

- HST Instrumentation Reclaims the UV (STIS,COS)

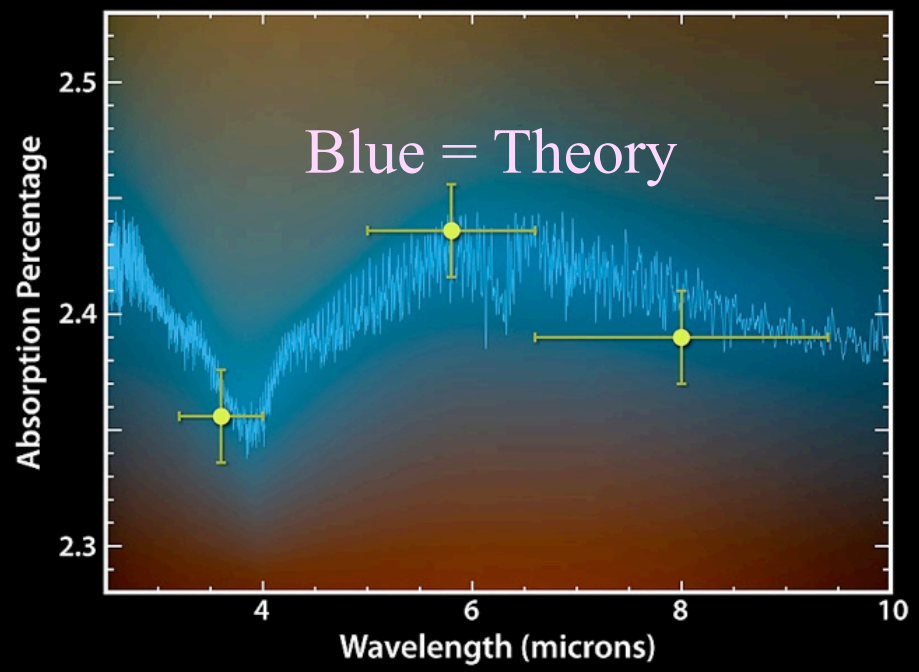




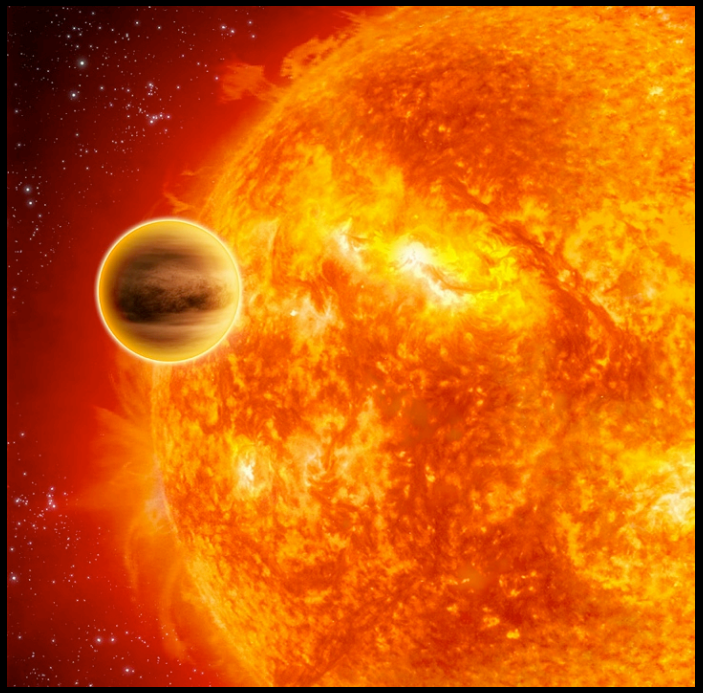
- “The astrophysical equivalent of a skunk”
- Absorption only one part in ten thousand

Exoplanets

- Spitzer exquisite photometry reveals thermal emission as a function of orbital phase



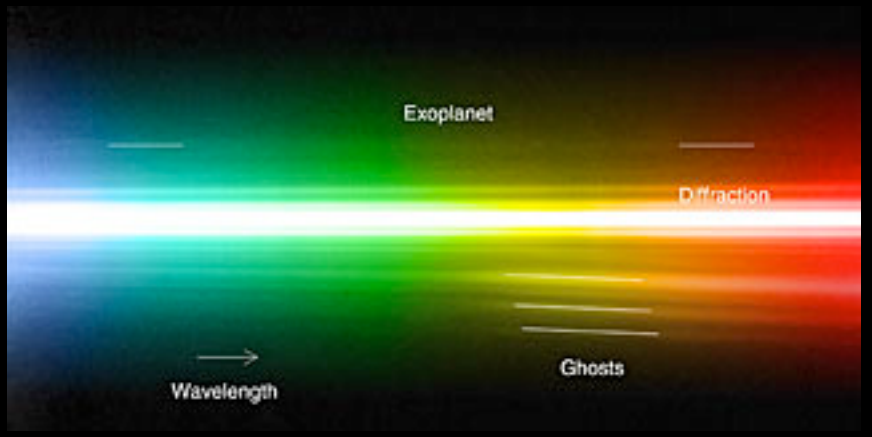
Water Signatures in Exoplanet HD189733b Spitzer Space Telescope • IRAC
NASA / JPL-Caltech / G. Tinetti (Institute d'Astrophysique de Paris) ssc2007-12a



- Evidence for water vapor
- Day/night temperature implies enormous global winds

Exoplanets

- JWST (2014) will be able to follow IR spectra with phase
- VLT (ground-based) IR spectra just obtained

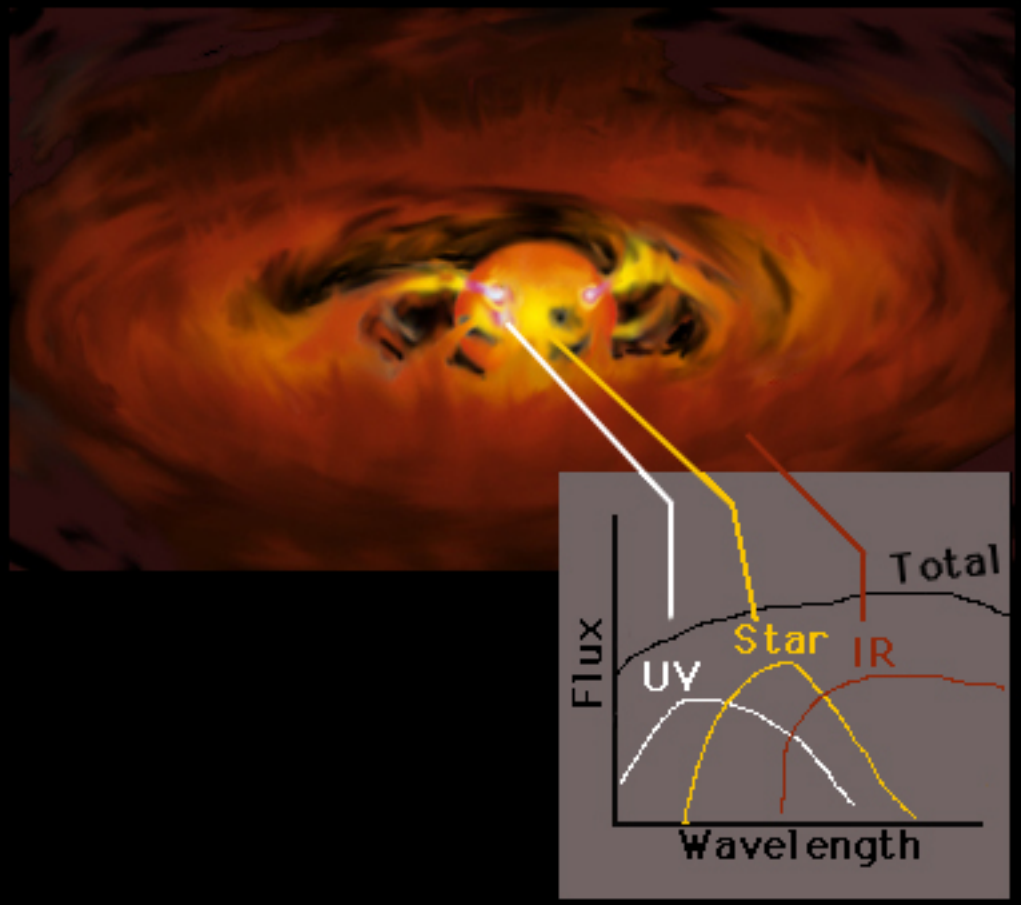


Radiation Hydrodynamic Physics

- Essentially the physics of planetary atmospheres but now with much richer array of planetary masses, irradiation sources
- Hydrodynamics of global circulation models
- Molecular excitation, dissociation and ionization
- Entrainment of irradiated atmosphere into stellar wind
- Aerosol formation and destruction
- Cloud deck locations and compositions
- Hot spots and long-lived storms

Broadens Potential Applications

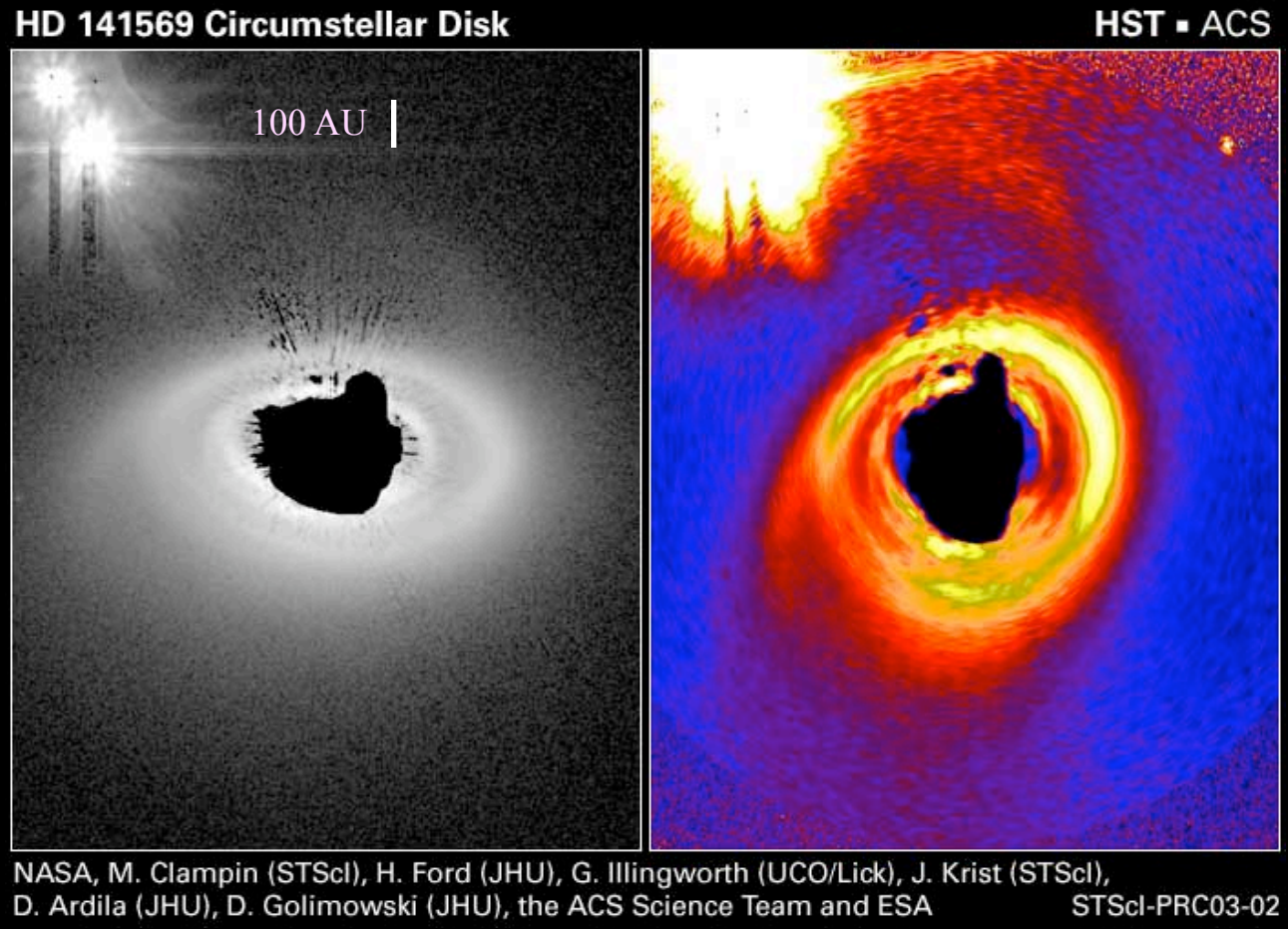
Star Formation



Accretion Disk Around a Young Star

Star Formation

HST images of complex spiral structure; JWST coming



Spiral arms heat, may rise and shadow disk, affecting spectral energy distribution

Star Formation

Spectral energy distributions: diagnosis of gaps and structure, require sensitive IR, mm, submm data

ALMA

SOFIA

LMT

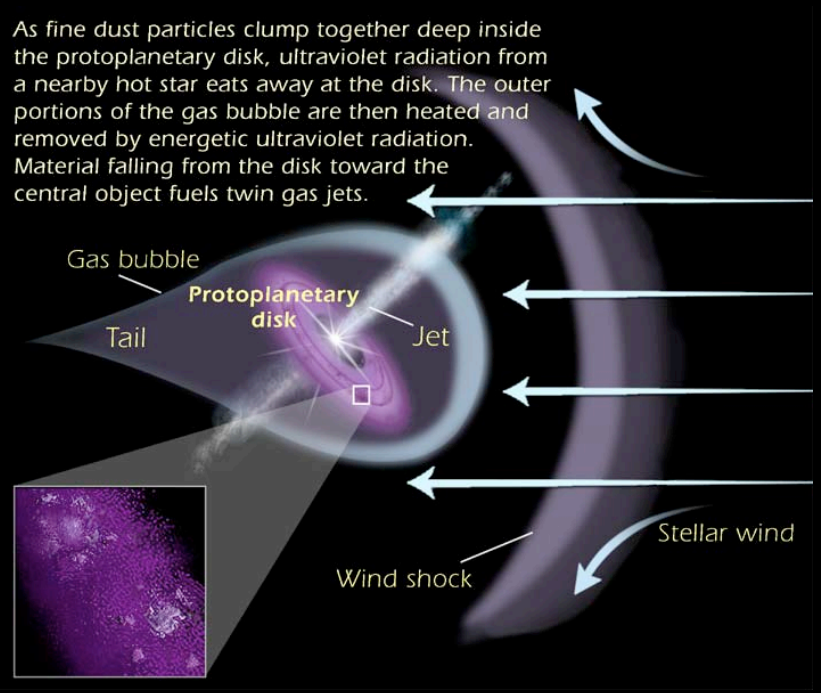
Ground-based IR Interferometers (Keck, VLT)

- All provide quantitative information on disk irradiation

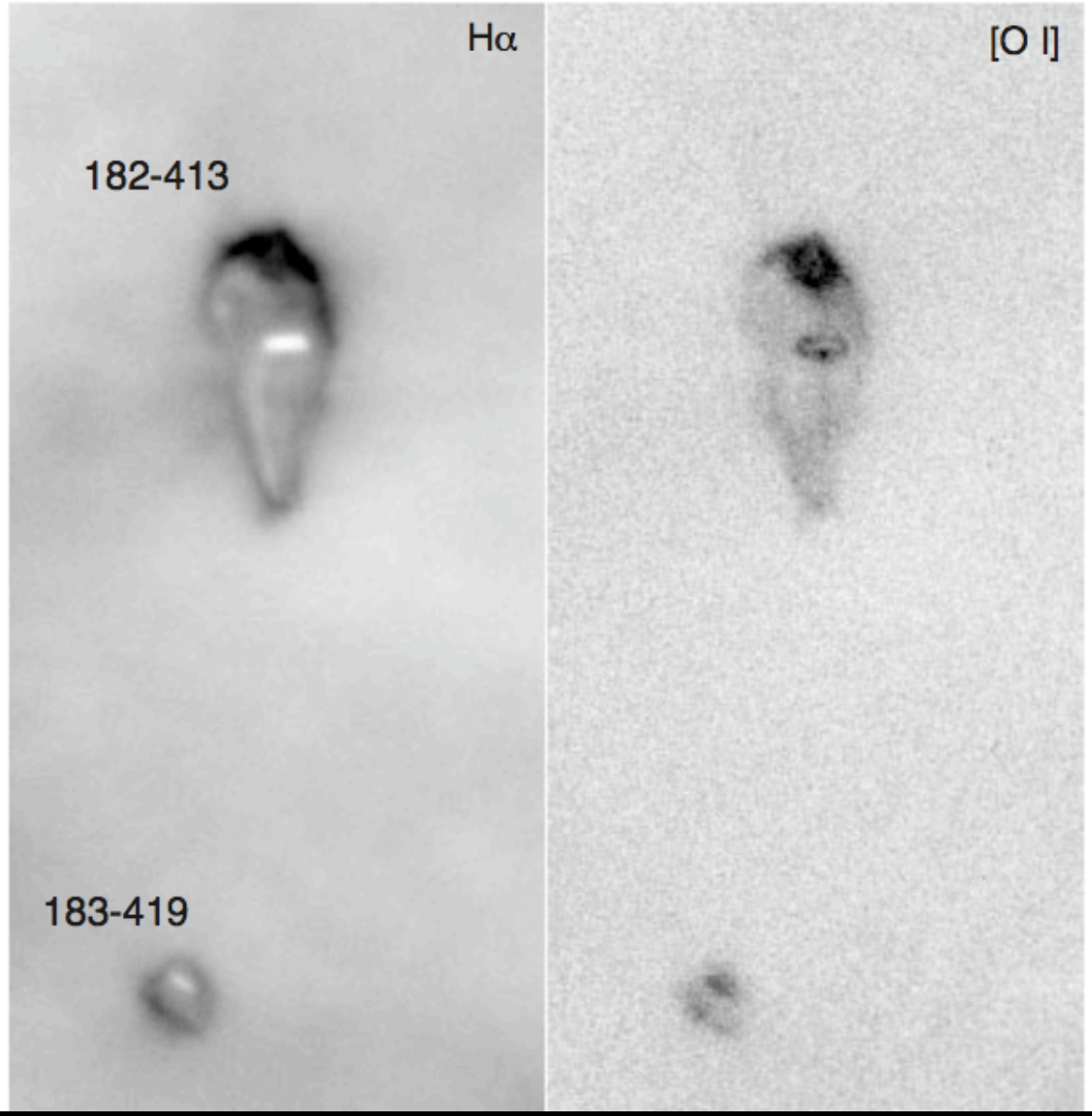
Star Formation

Typical scenario of a low mass star forming in a region of high mass star formation

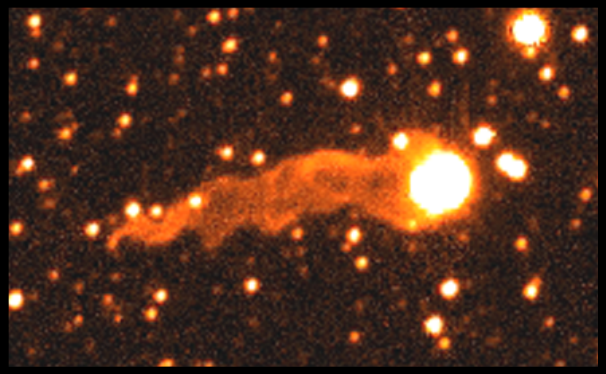
Bally et al 2000

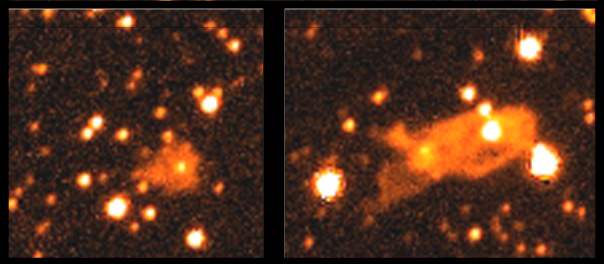


HST now; Ground-based adaptive optics coming in the optical...

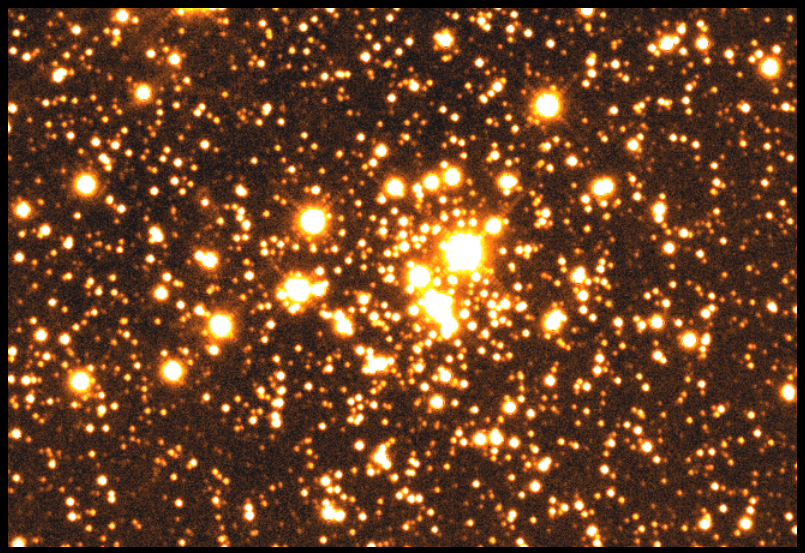

Hα
[O I]
182-413
183-419

Star Formation





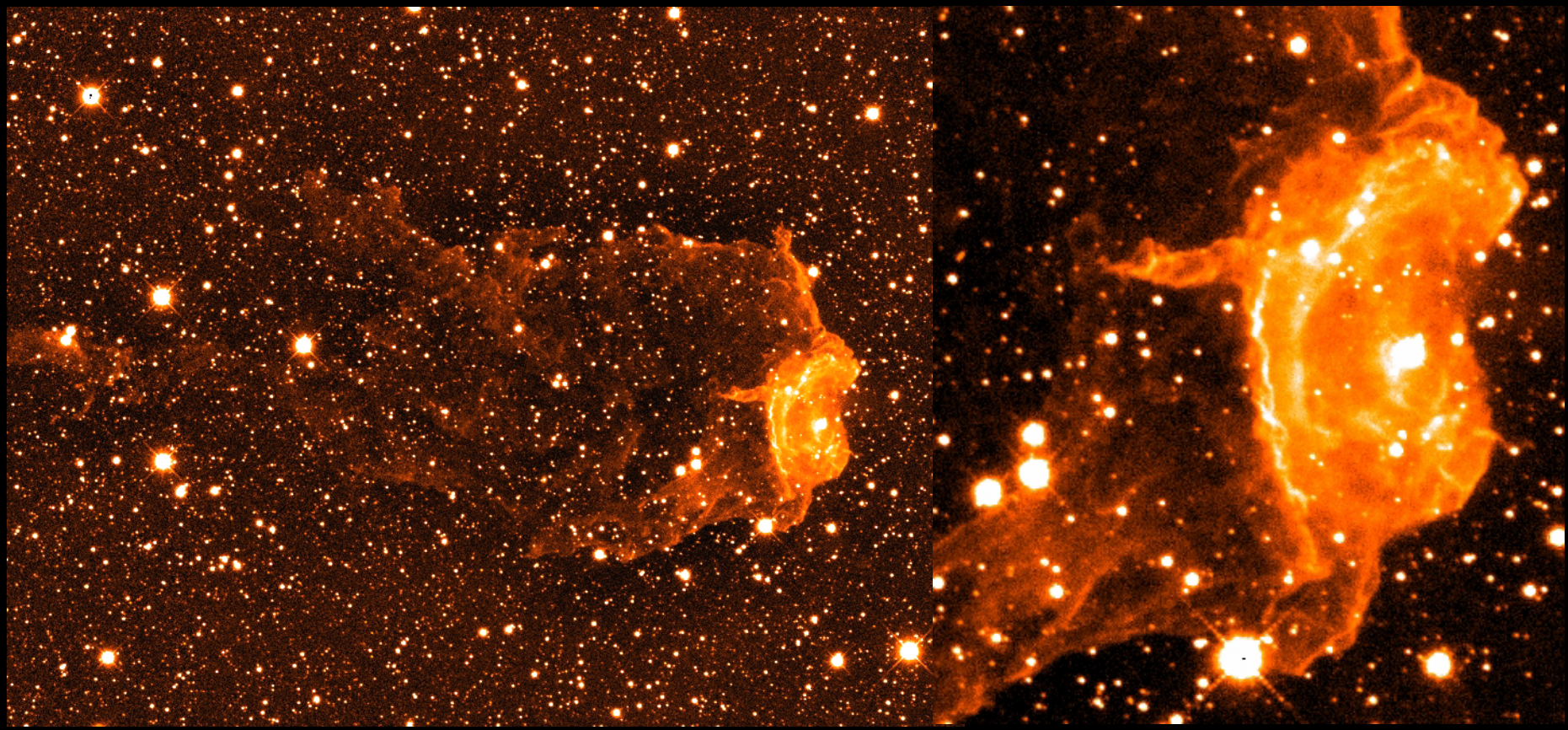
Irradiated Globules



Cluster of O Stars

Large-scale ground-based IR surveys of Fluoresced H2: A way to see UV absorption through dust!

Star Formation



More large-scale surveys being made

Radiation Hydrodynamic Physics

- Radiative evaporation of gaseous disks
- Dynamical effects of radiation on dust
- Entrainment of disk material in a wind
- Fluid instabilities (globules)
- Coupling of magnetic fields to partially ionized gases, generation of dynamos
- Angular momentum transport in disks
- Dynamics of radiatively cooling shock waves in jets