Water in the Disks Around Massive Young Stars

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Water in the disks around massive young stars

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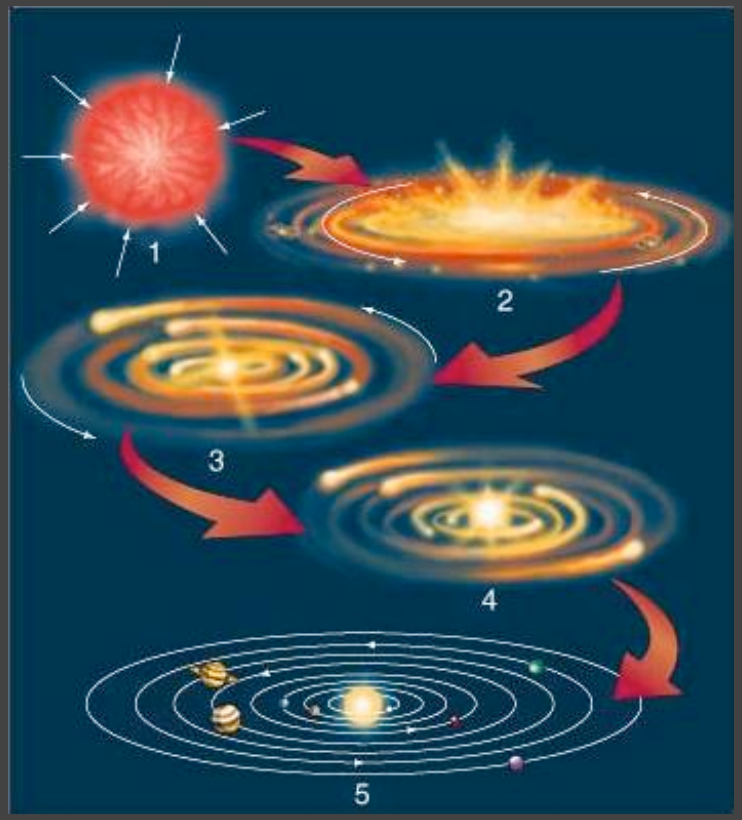
Formation of stars and planets



Diversity of stellar masses

Initial conditions for planet formation

ALMA Band 5: use water as tracer for disk structure & chemistry

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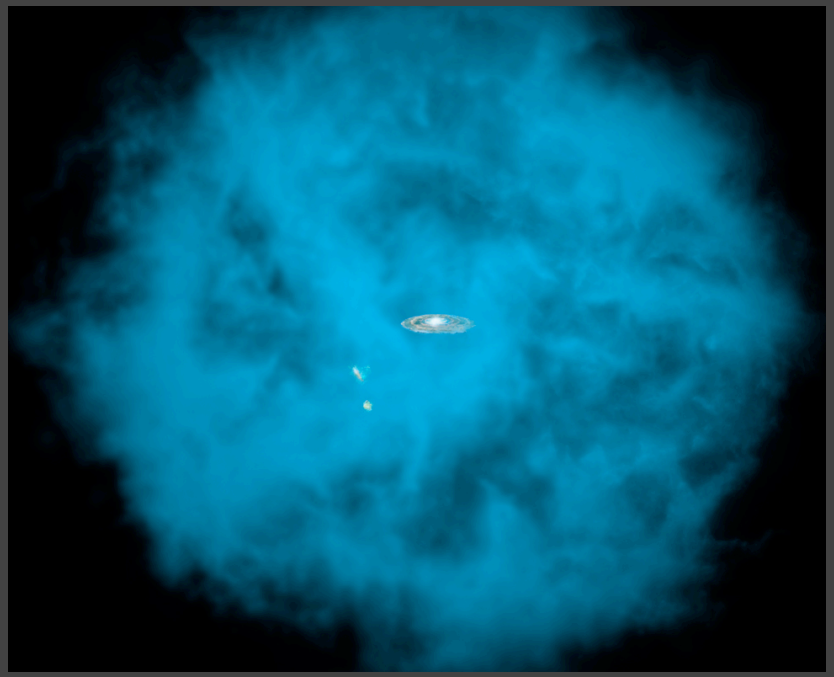
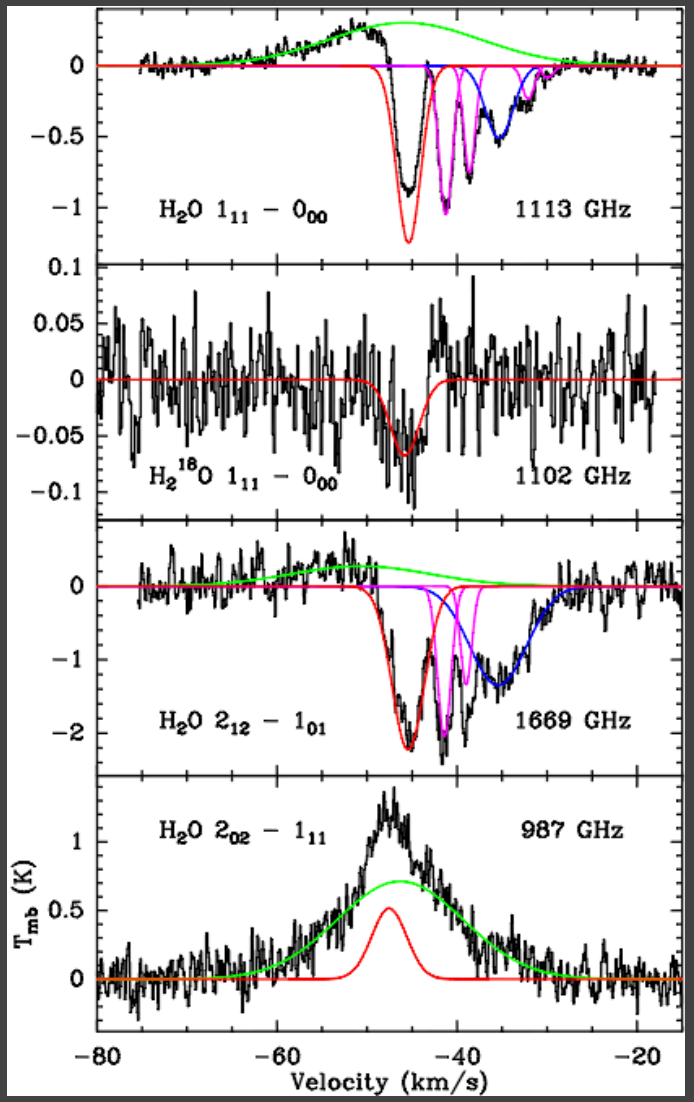
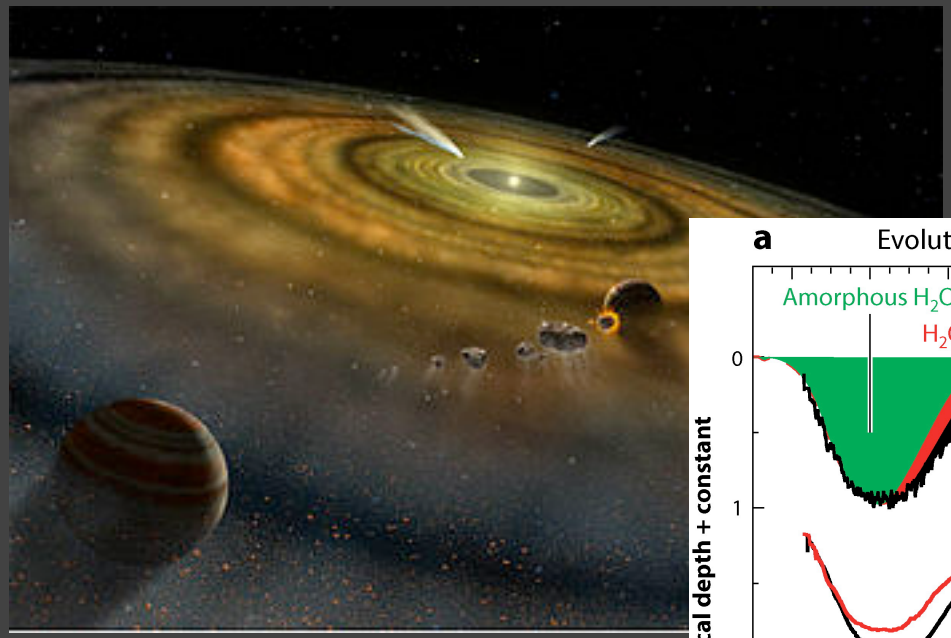
Water vapour: Cooling of collapsing gas clouds

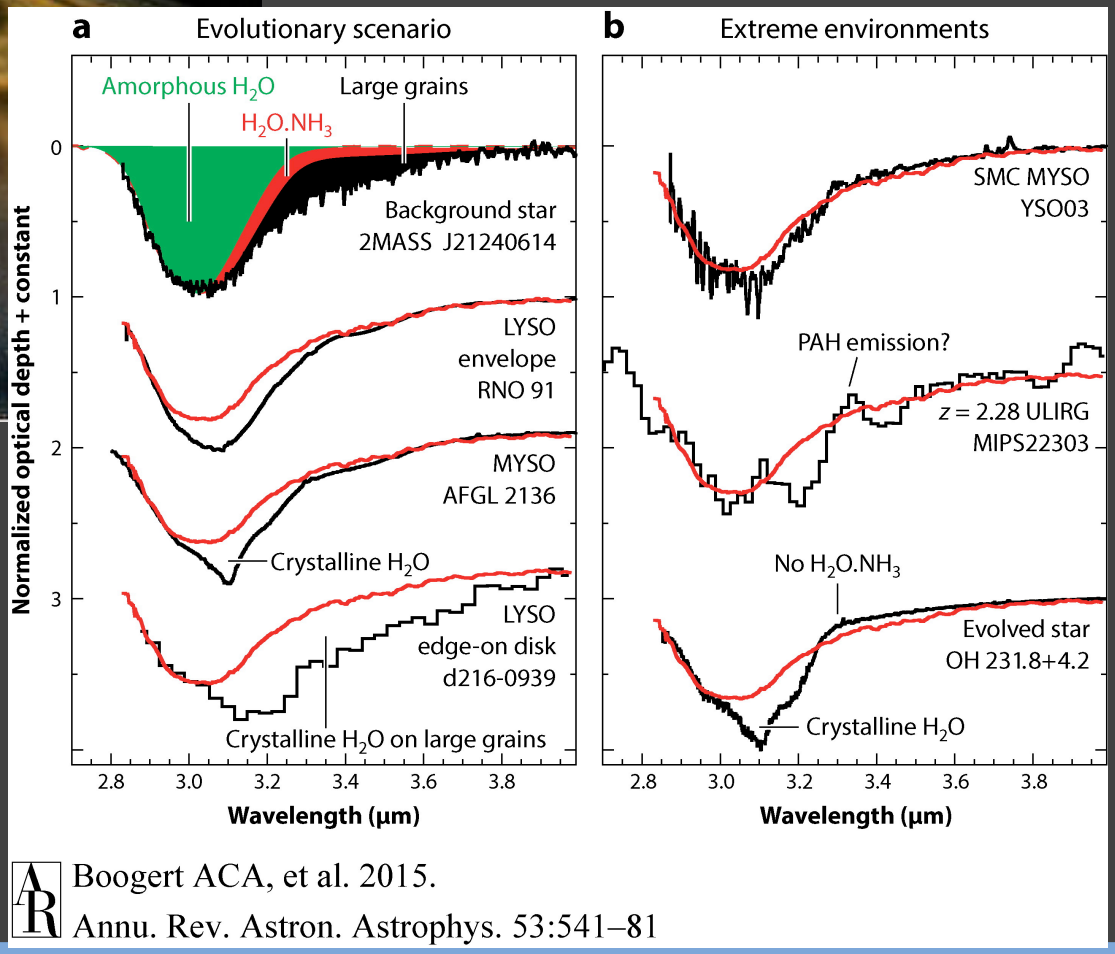




Van der Tak et al 2013

Water ice: The glue to coagulate grains in disks





Boogert ACA, et al. 2015.
Annu. Rev. Astron. Astrophys. 53:541–81

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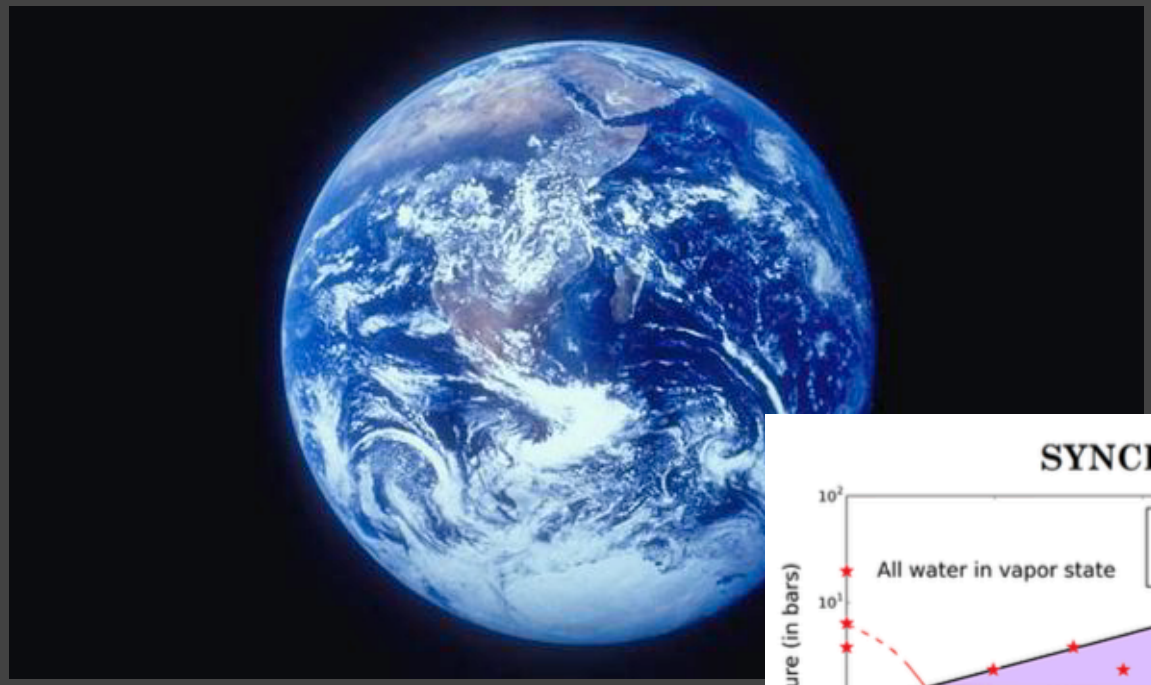
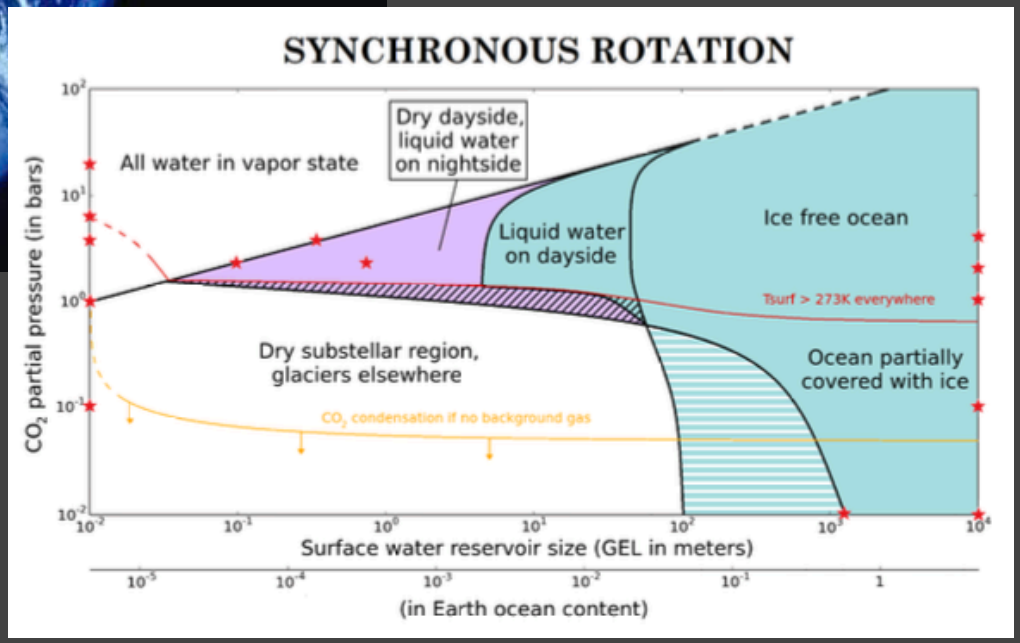
Liquid water: Transports organics on planets



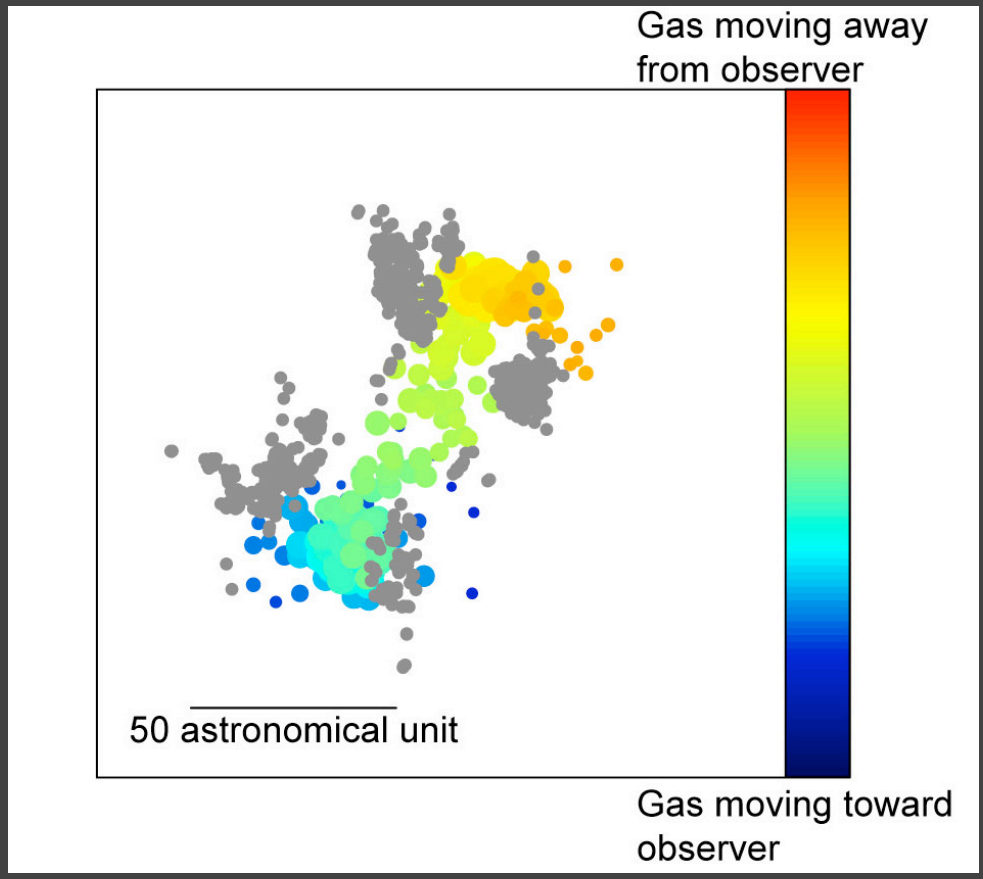


Turbet et al 2016; Burrows et al 2017

Water from the ground: Nothing new ☺

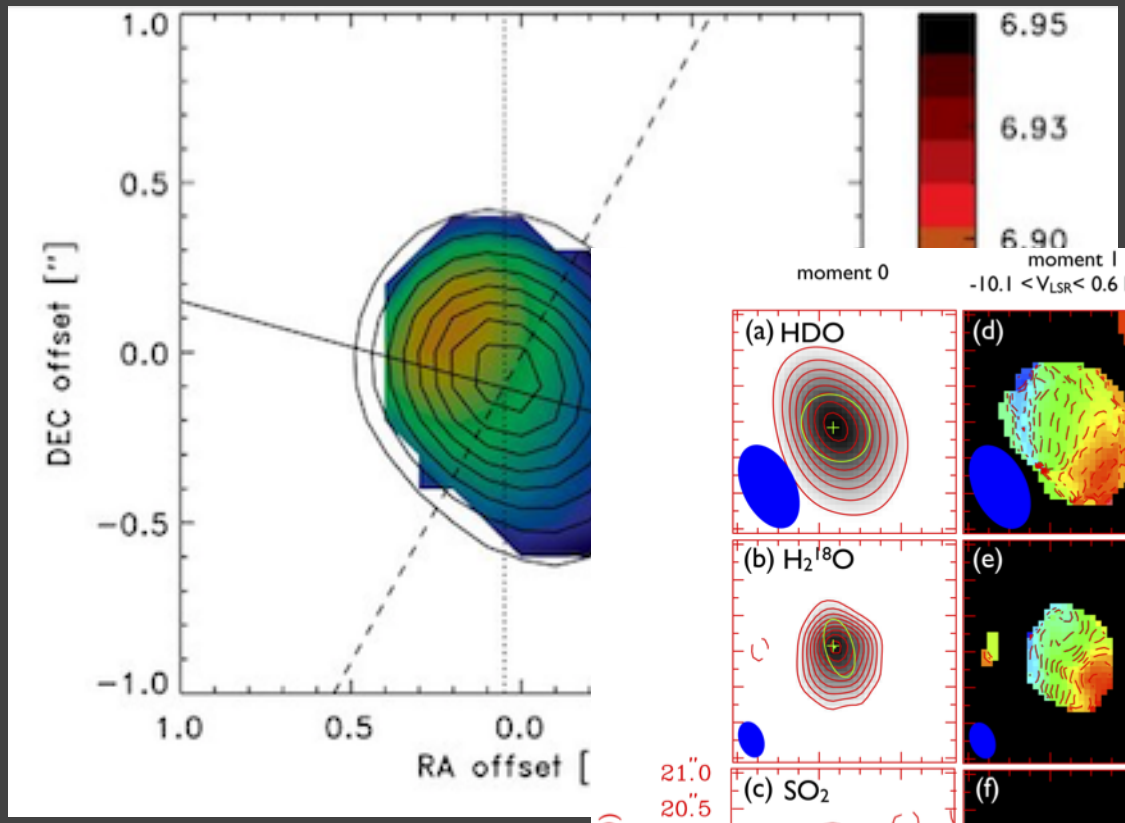
H_2O 183 GHz line: small scale kinematics

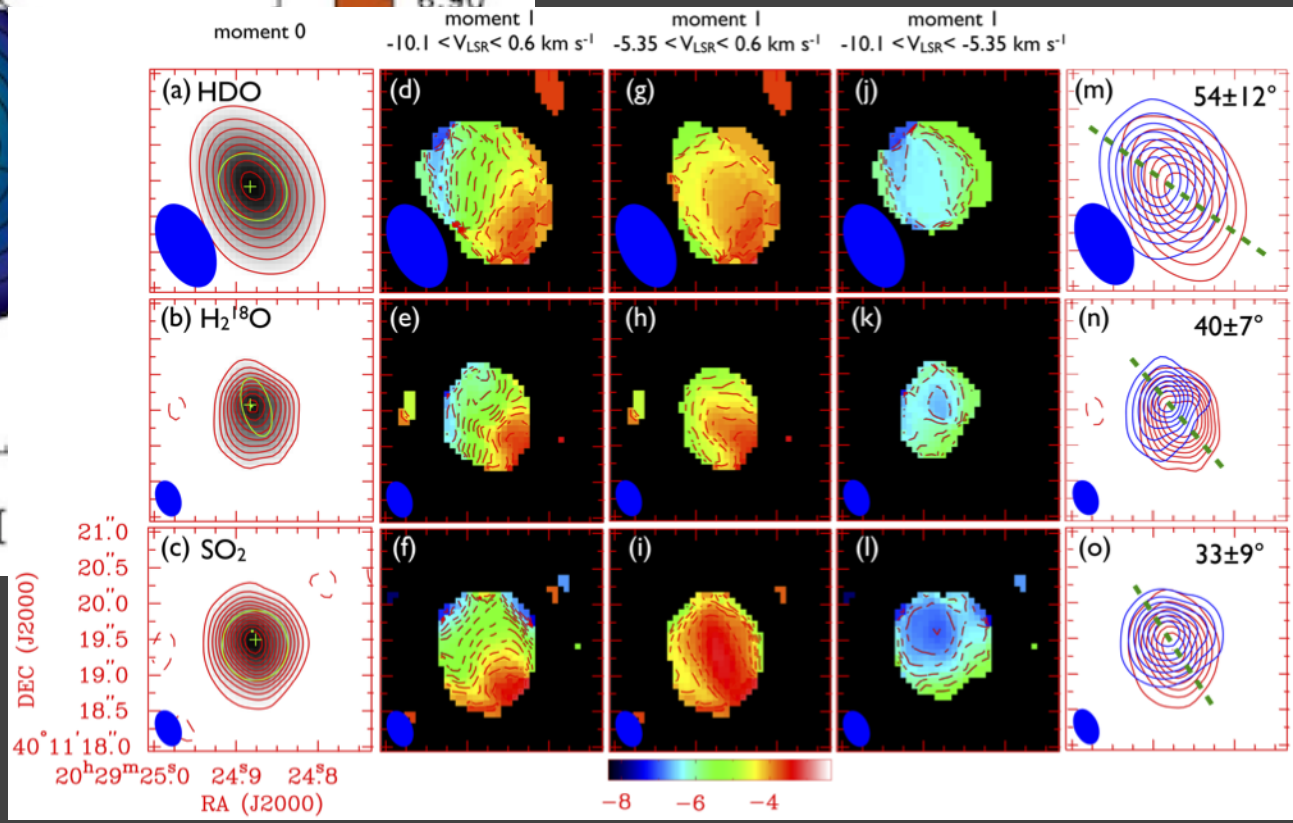
with 336, 321 GHz lines: constrain excitation conditions



ALMA observations of Orion Source I: Hirota et al 2014

Thermal water emission from protostellar disks





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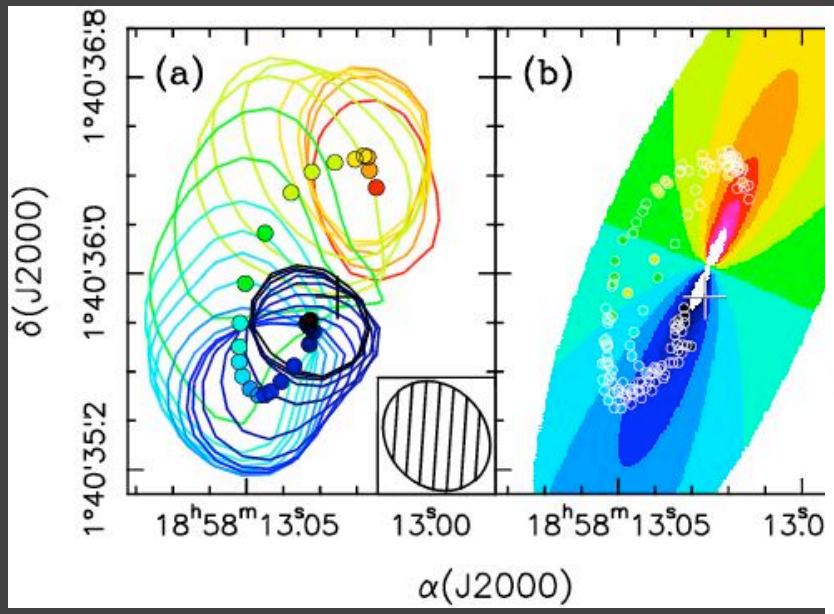
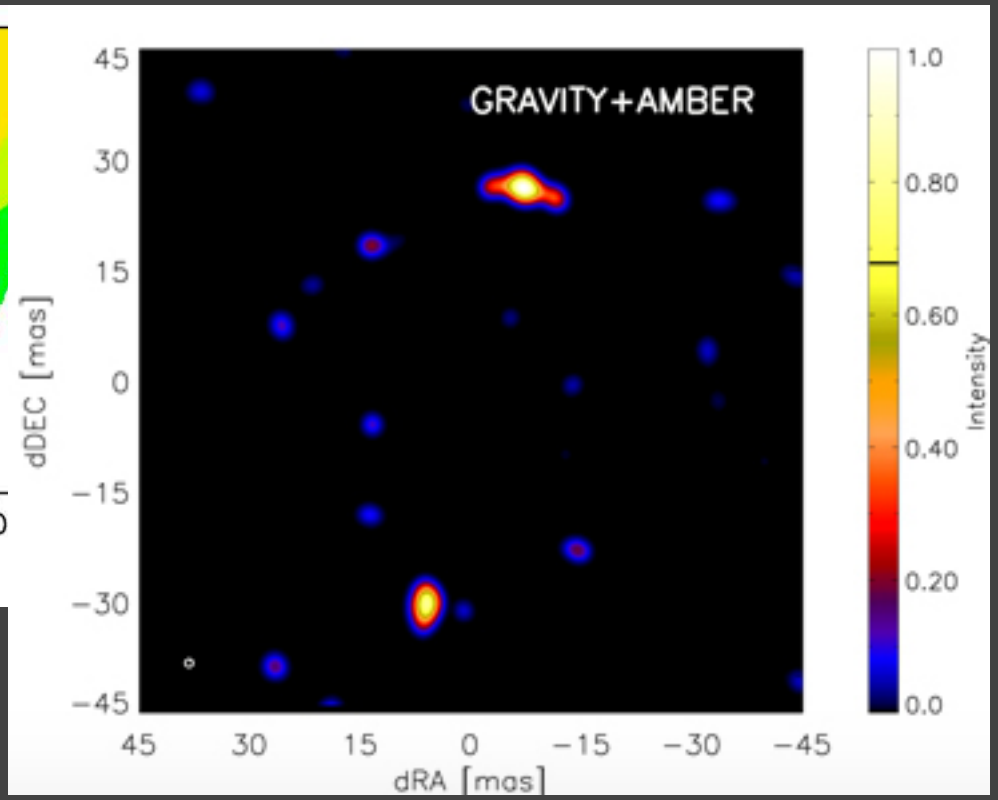
Jørgensen et al (2010): low-mass
Van der Tak et al (2006), K.S. Wang et al (2013): high-mass

Disks around young high-mass stars

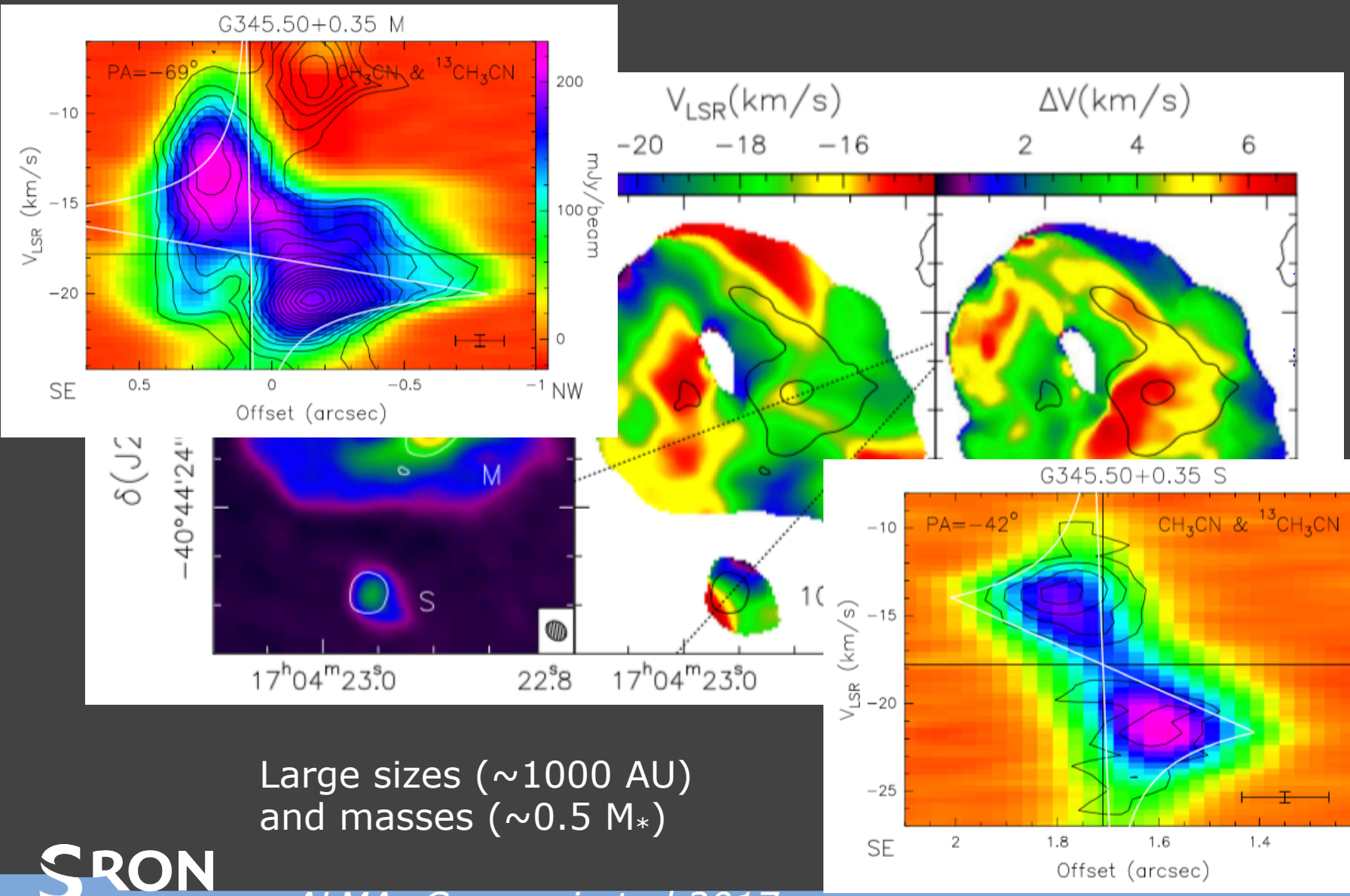




Up to B-type established (de Wit & Beltrán 2016)
First candidate O-type: Johnston et al 2015

Sánchez-Monge et al 2013; Kraus et al 2017

Candidate disks around O-type protostars



Large sizes (~1000 AU)
and masses (~0.5 M_*)

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ALMA: Cesaroni et al 2017

Substructure of massive circumstellar disks

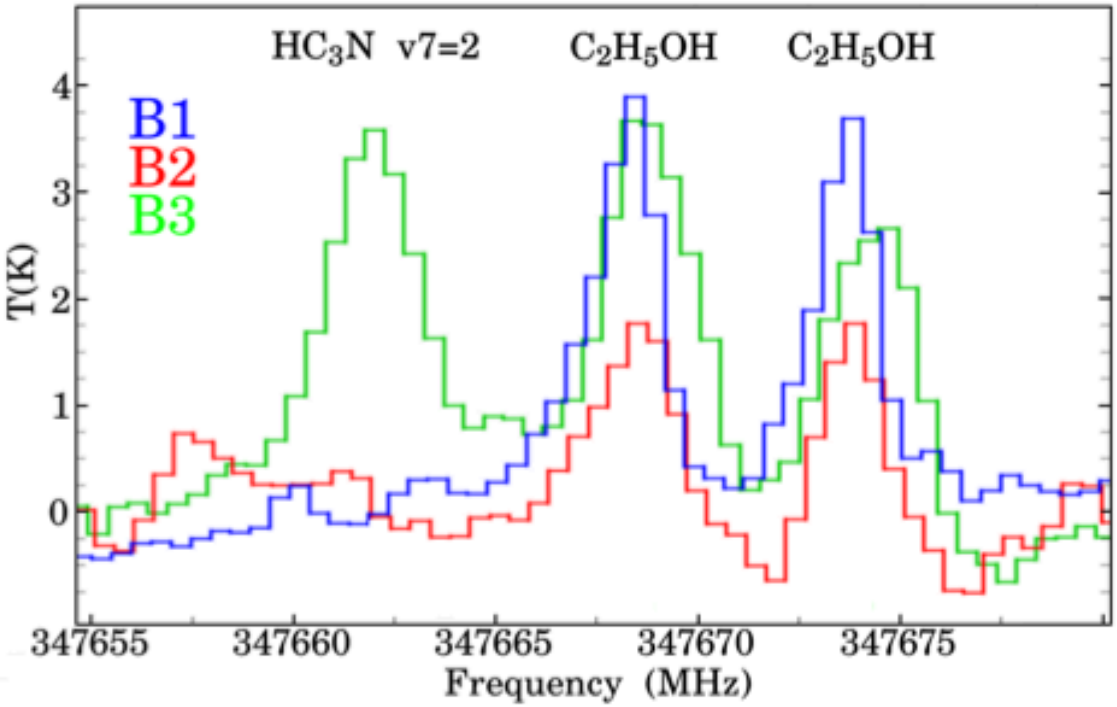
Strong organic emission from high-mass protostars

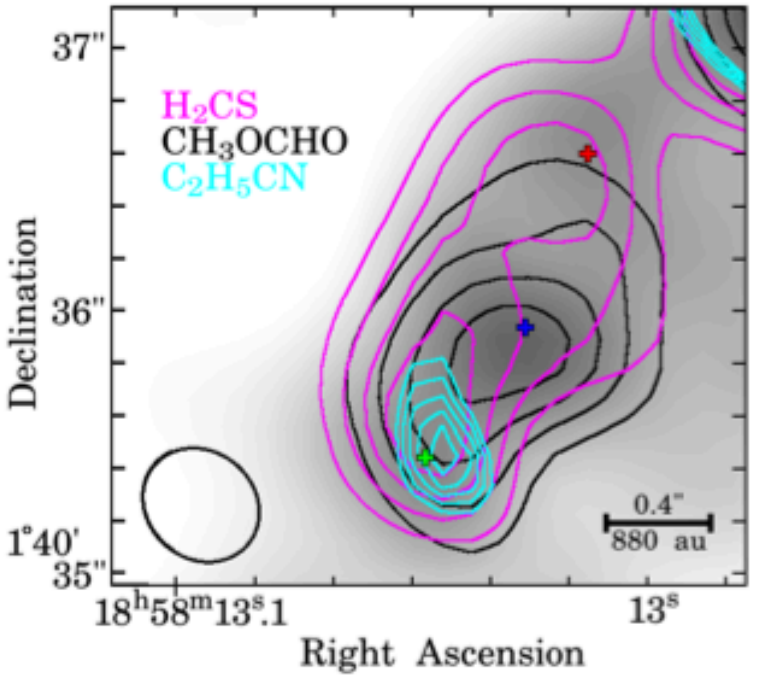
origin in disk, inner envelope or outflow cavity?

Chemical segregation seen on ~1000 AU scales

especially in N- and D-bearing species (model with C. Walsh)

Variation in temperature, density, ...?





ALMA observations of G35.20: Allen et al 2017

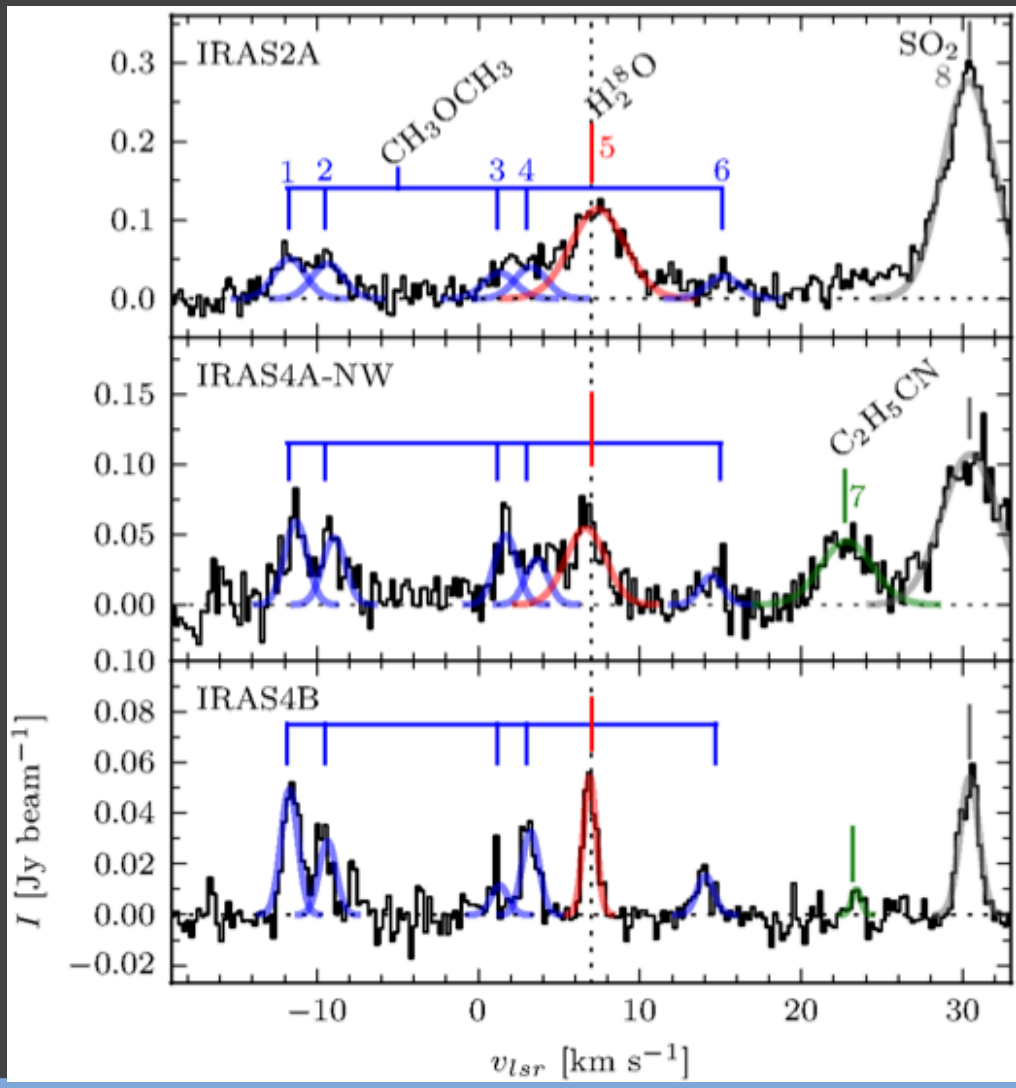
Band 5: A chemical goldmine

Thermal $H_2{}^{18}O$ emission:
location snowline
thermal structure

CH_3OCH_3 lines:
grain surface chemistry
also C_2H_5CN

SO_2 line:
shock chemistry
system geometry

Band 5 resolution 0.3''
= 600 AU at 2 kpc
= well within snowline
(~1000 AU for 10^4 L_0)



Persson et al 2012

Conclusion: Band 5 is cool!

whether you like chemistry or not ...