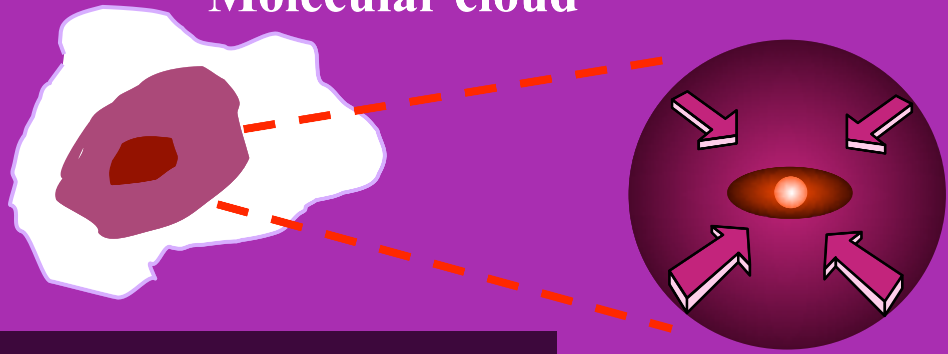
Molecular cloud

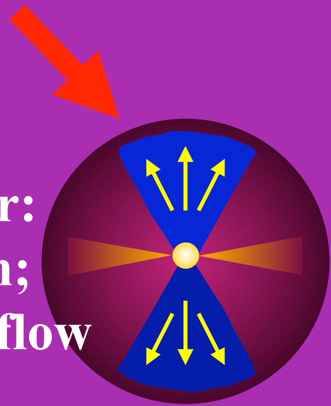


Gravitational collapse

↔ 10 000 AU

HEART OF DARKNESS

INTERSTELLAR GAS AS OBSERVED FROM ARCETRI

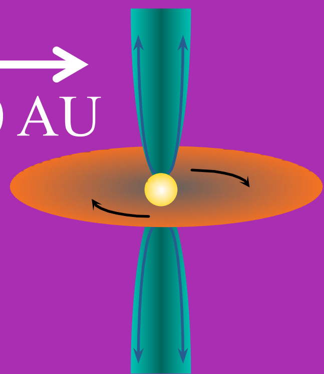


Protostar: accretion; jet + outflow

$(t = 10^4 - 10^5$ yr)

C. CODELLA , on behalf of the Arcetri Star Formation & Stars Group

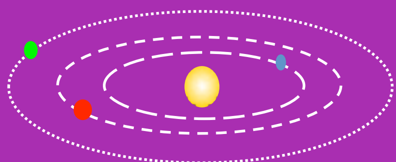
↔ 100 AU



T-Tauri Star: accretion disk + jet

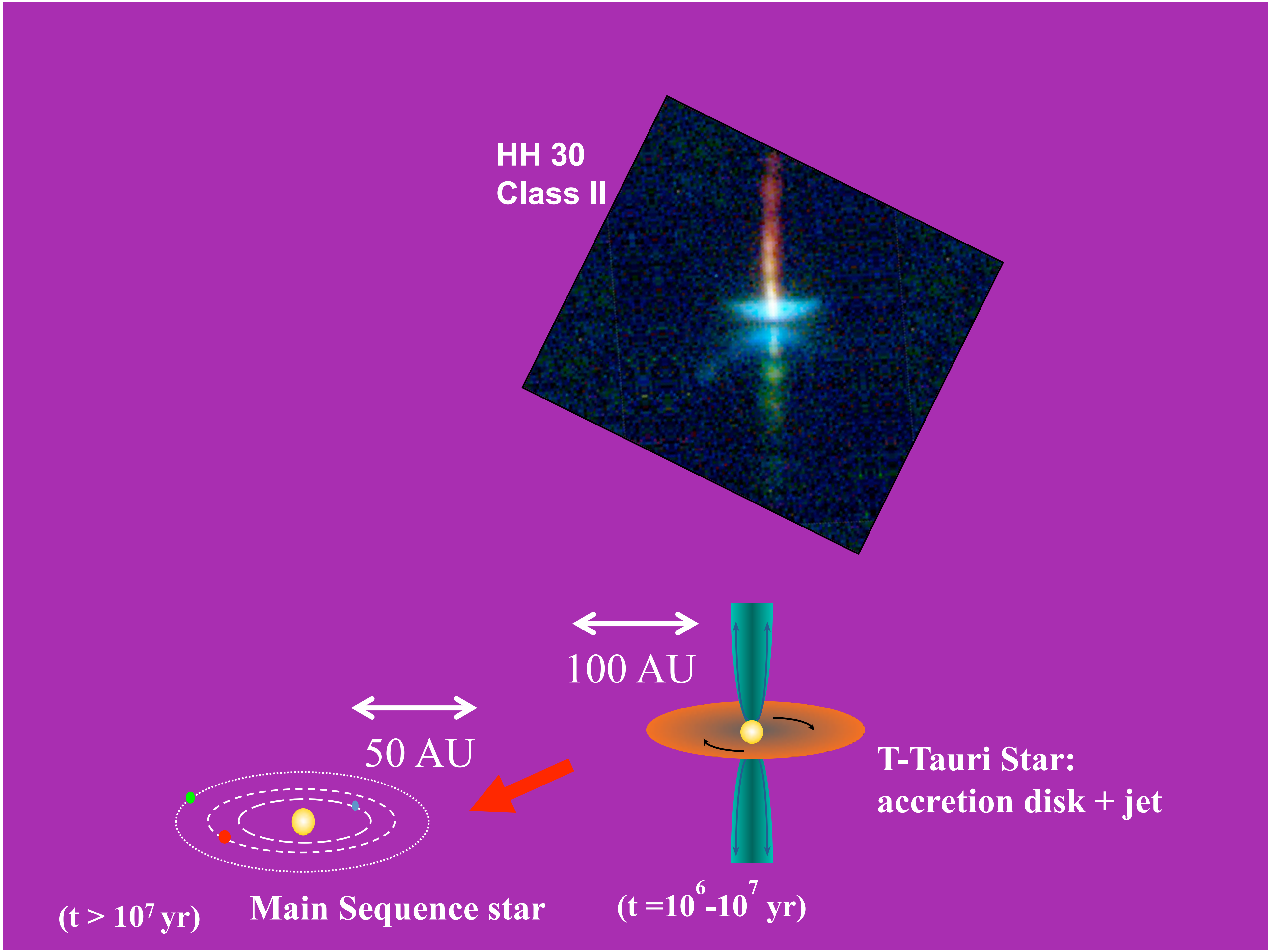
$(t = 10^6 - 10^7$ yr)

↔ 50 AU



$(t > 10^7$ yr)

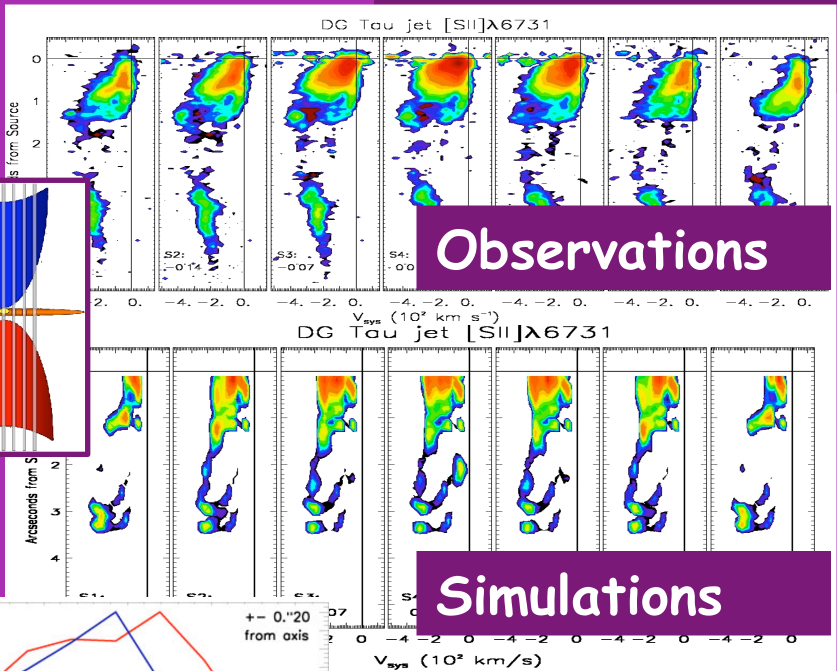
Main Sequence star


HH 30
Class II
100 AU
50 AU
T-Tauri Star:
accretion disk + jet
(t > 10^7 yr)
Main Sequence star
(t =10^6-10^7 yr)

Anatomy of spectral jets

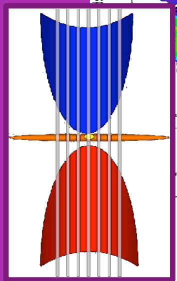
High spectral resolution with HST !

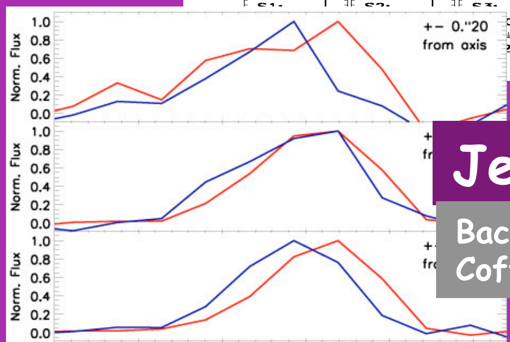
Main goal: to constrain launch mechanism



Observations

Simulations

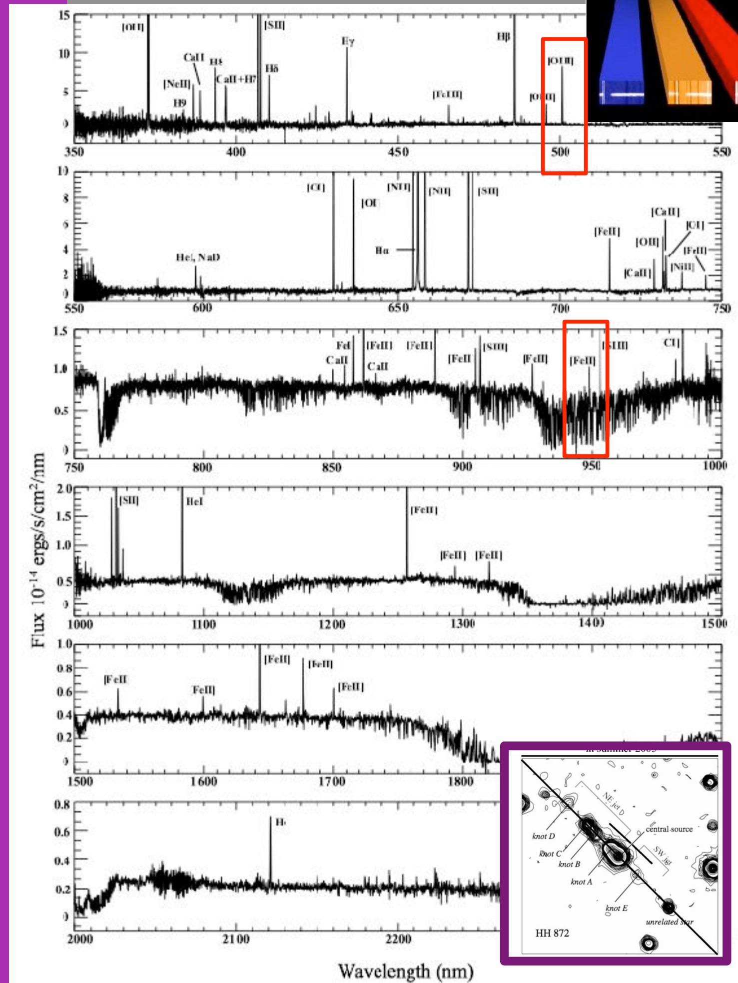




Jet rotation !

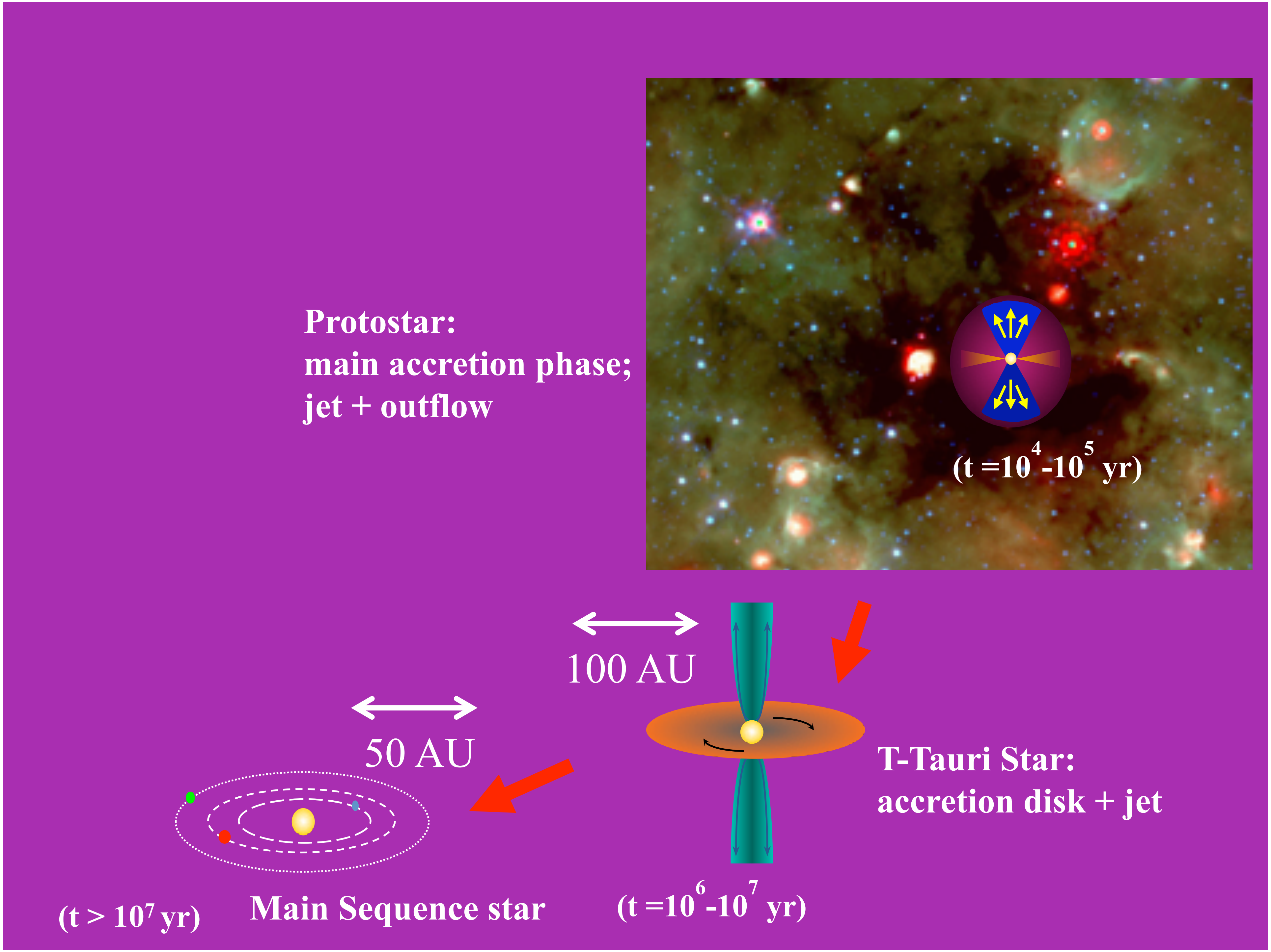
Bacciotti et al. (2000), Coffey (2012)

Excitation conditions with X-shooter !

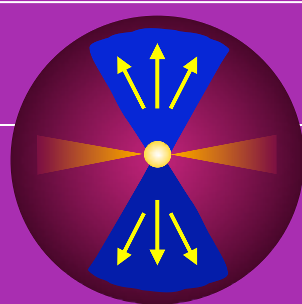


Simultaneous 3500 Å - 2.4 μm spectrum: direct estimate of Ṁ eject / Ṁ acc

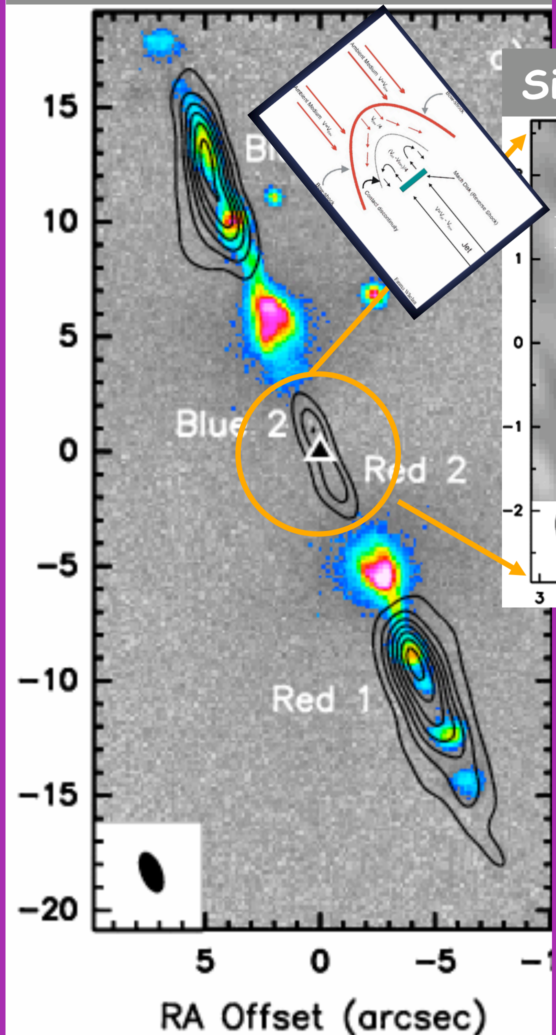
Bacciotti et al. (2011)


Protostar:
main accretion phase;
jet + outflow
(t =10^4-10^5 yr)
100 AU
50 AU
T-Tauri Star:
accretion disk + jet
(t > 10^7 yr)
Main Sequence star
(t =10^6-10^7 yr)

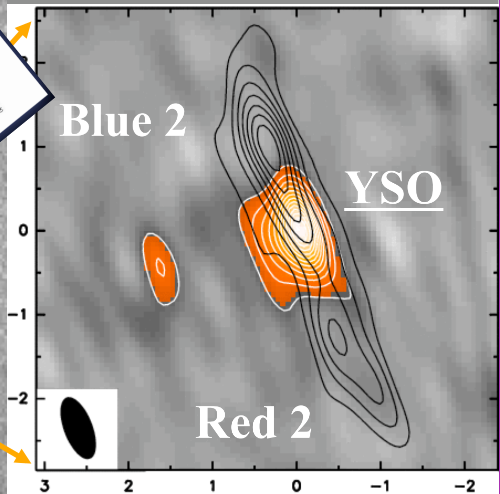
Digging in the dark



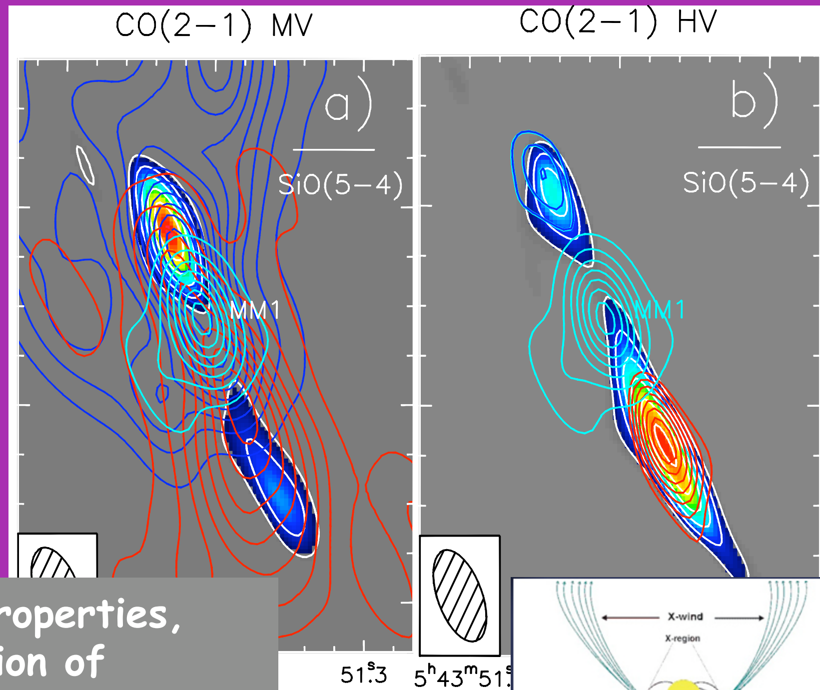
SiO(2-1) vs. (IR) H_2



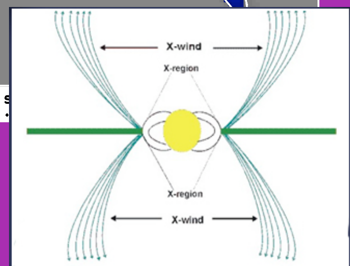
SiO(5-4) vs.1.4mm



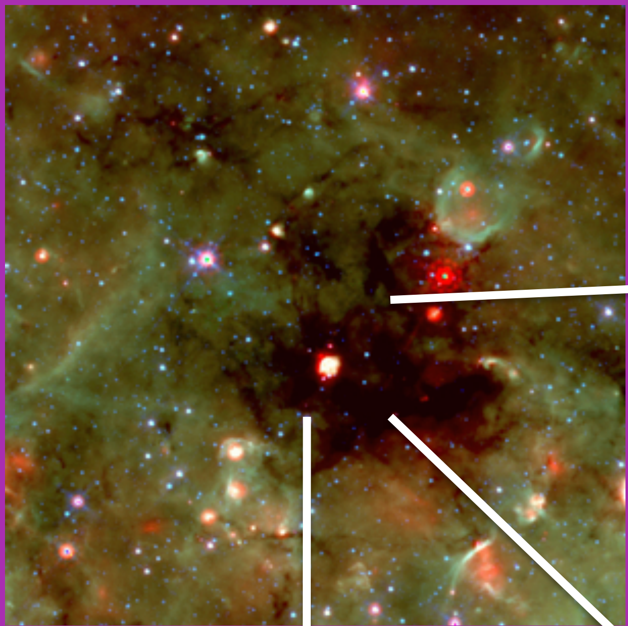
Protostellar system: primary jet from a Class 0 protostar (Codella et al. 2007, 2012)

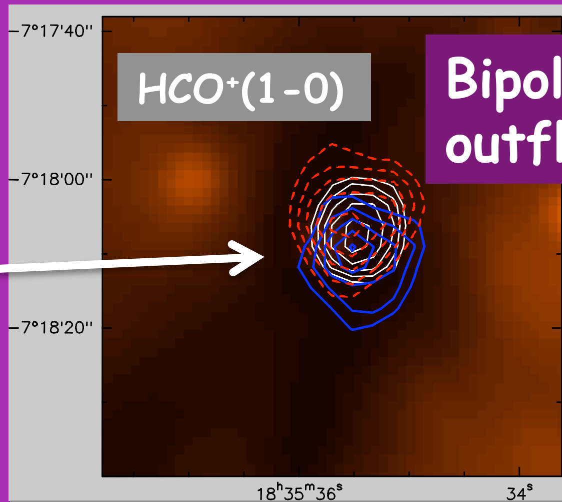


Kinematics, physical properties, and chemical composition of protostellar jets: EARLY SCIENCE ALMA project (PI Codella) + Large Program IRAM PdBI



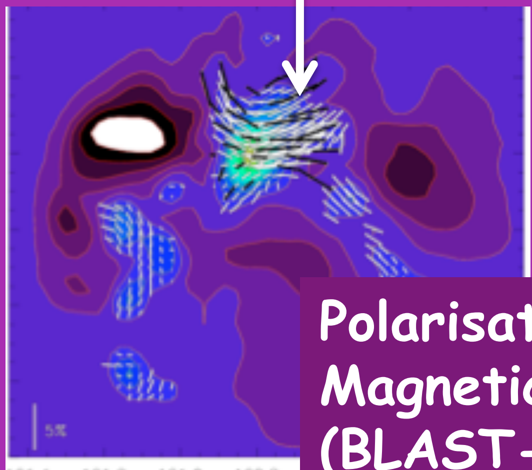
The cradle of a (massive) star





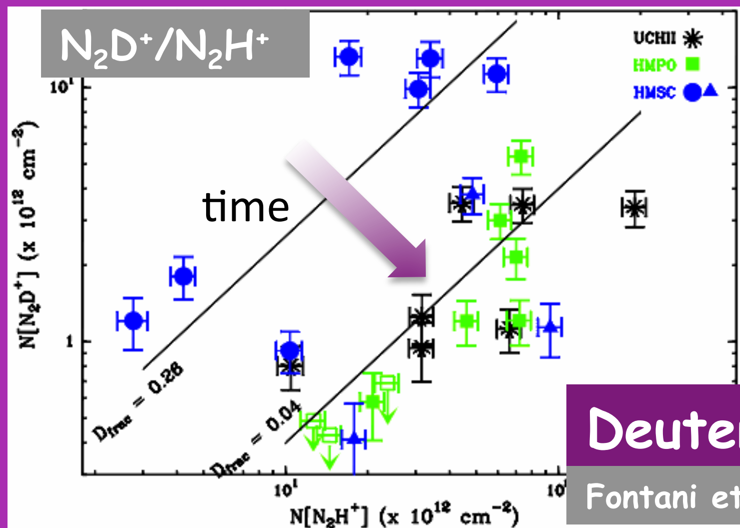
Bipolar swept-up outflow !

Lopèz-Sepulcre et al. (2010)



Polarisation, Magnetic field ! (BLAST-Pol)

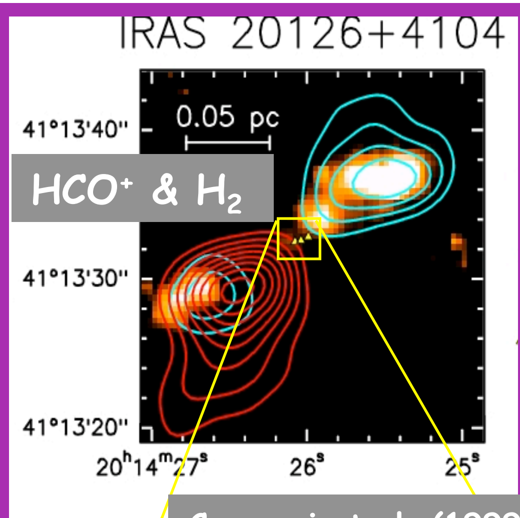
Olmi et al. (2010)

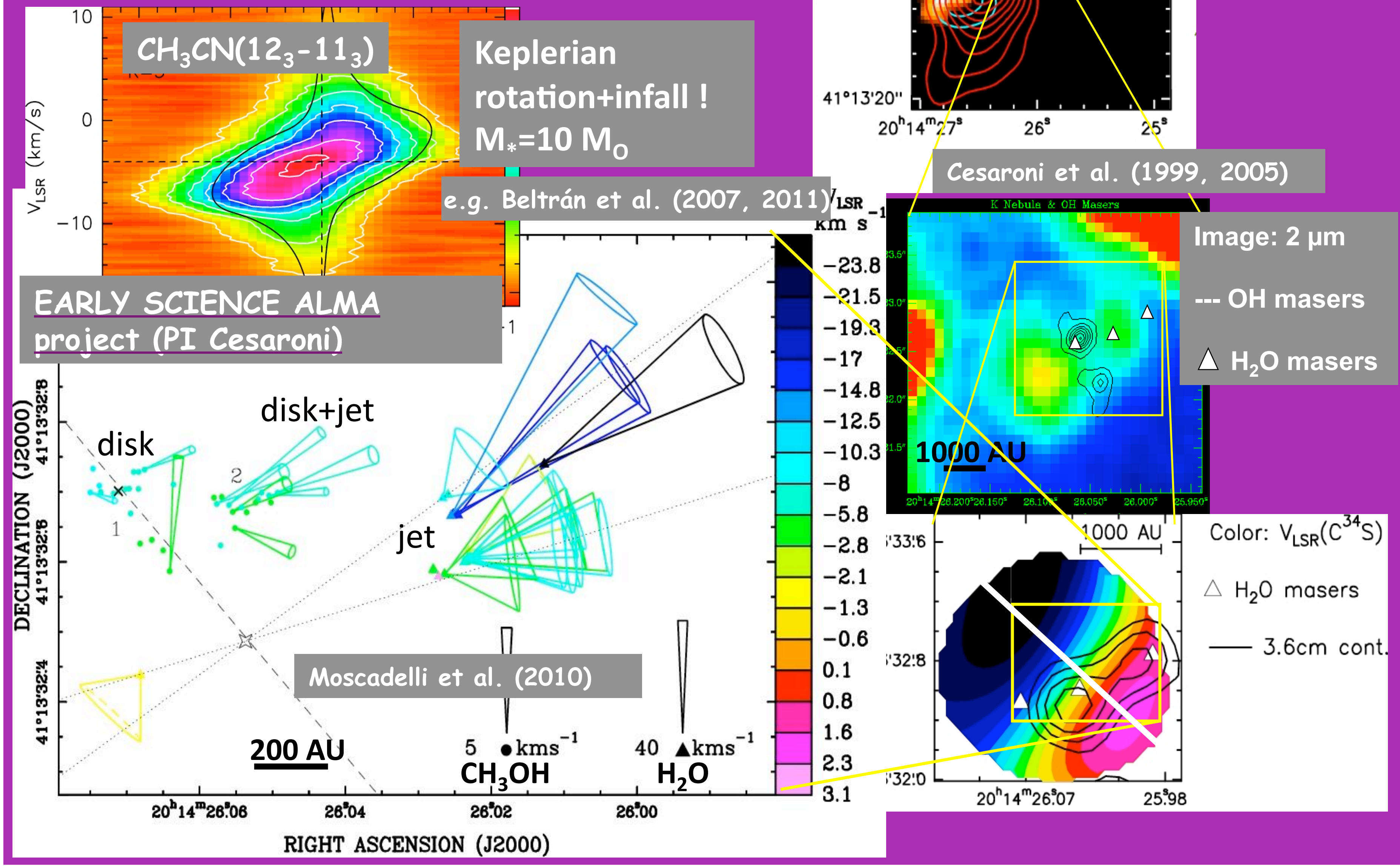


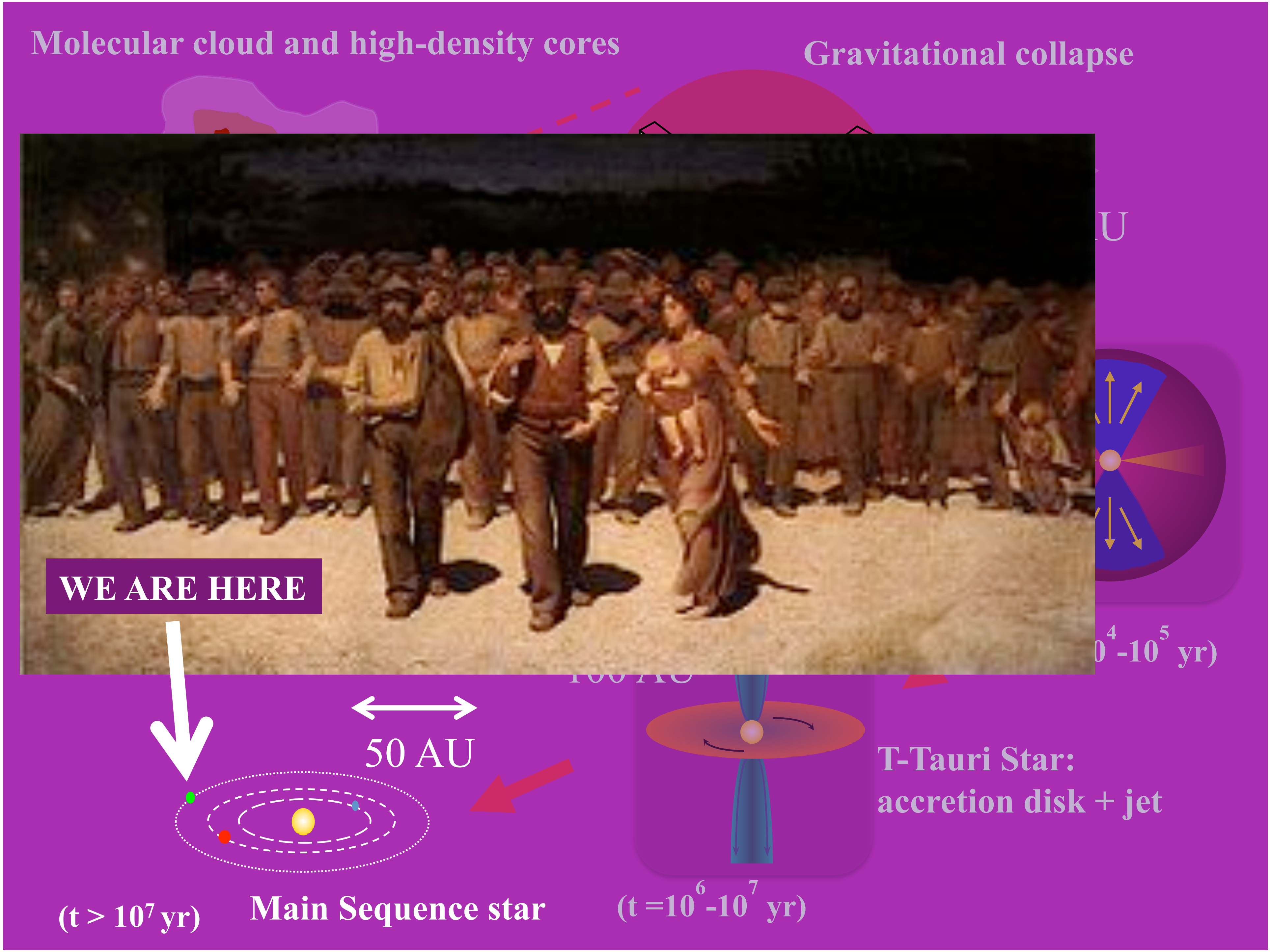
Deuteration !

Fontani et al. (2011)

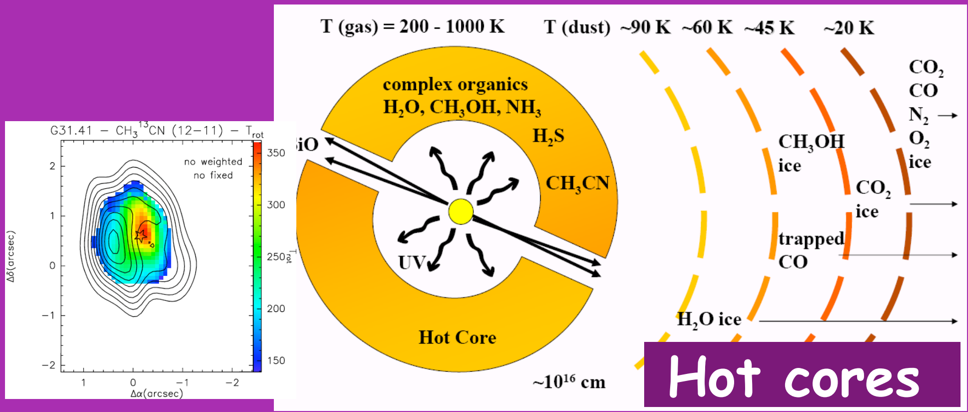
Formation of massive (proto-)stars



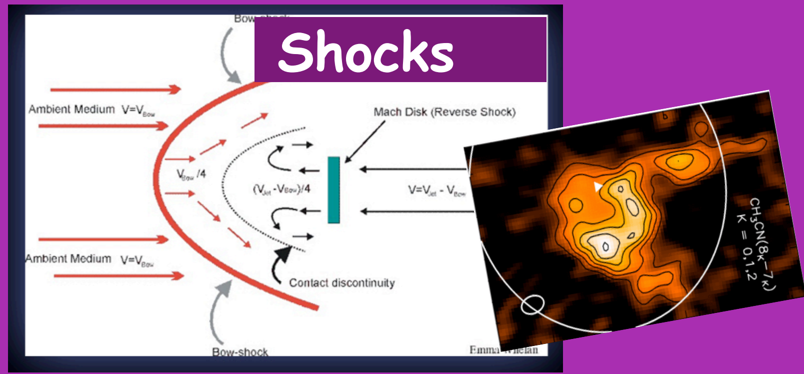



Molecular cloud and high-density cores
Gravitational collapse
WE ARE HERE
50 AU
T-Tauri Star:
accretion disk + jet
(t > 10^7 yr)
Main Sequence star
(t =10^6-10^7 yr)

Our Chemical Origins

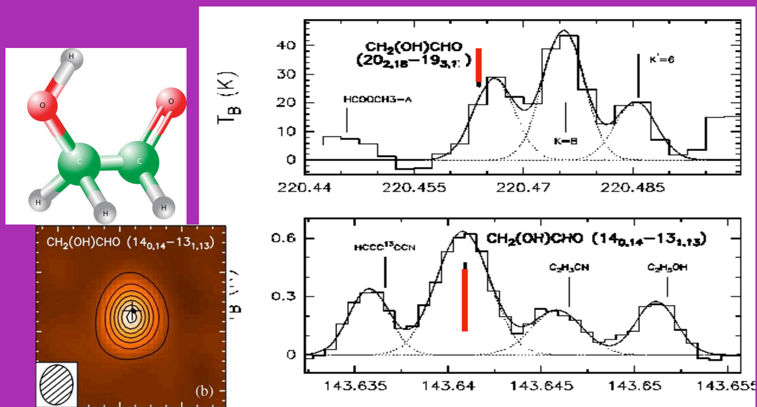


Hot cores



Shocks

Complex Organic Molecules !

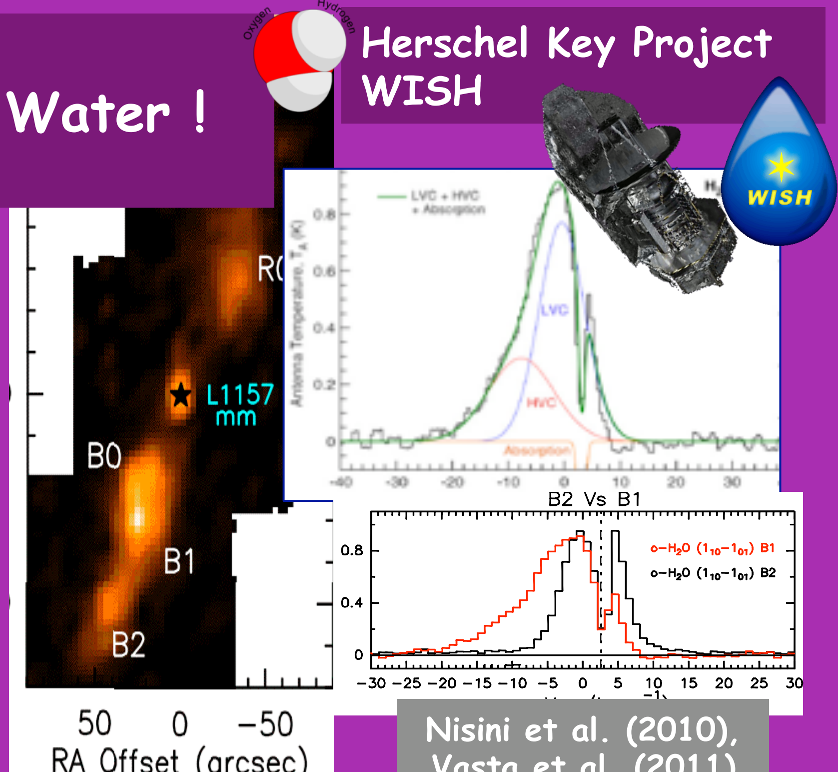


First detection of Sugar around protostars !

Beltrán et al. (2009)

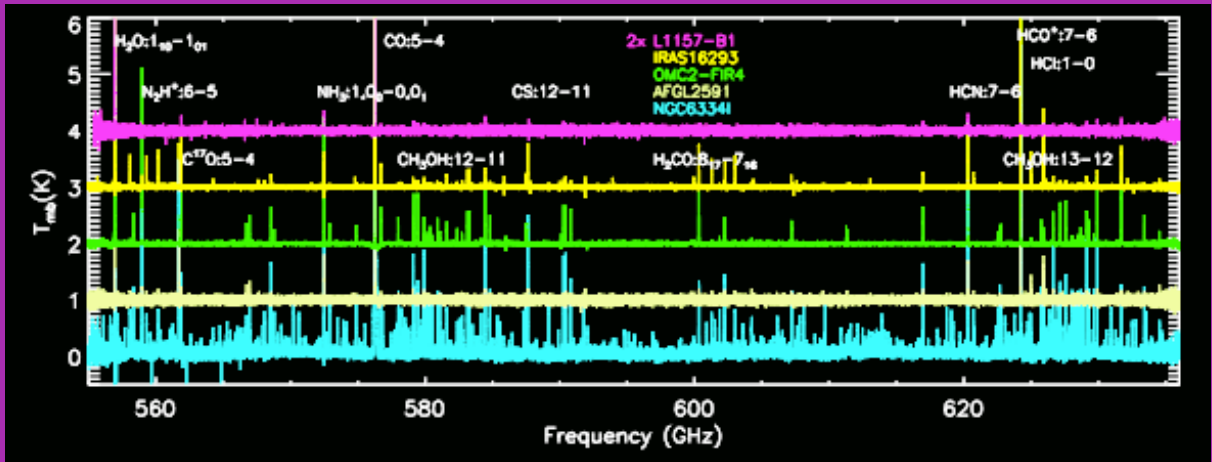
Water !

Herschel Key Project WISH



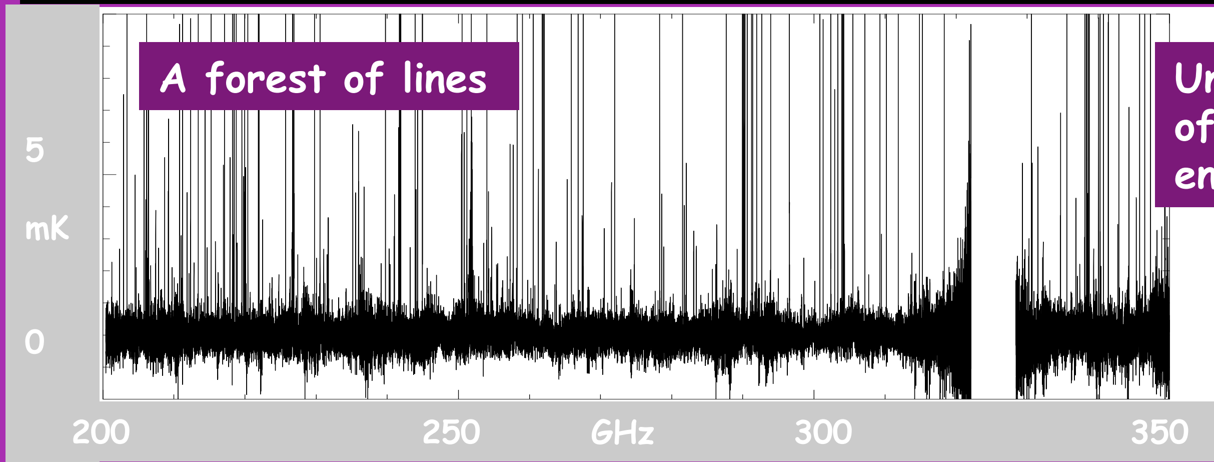
Nisini et al. (2010),
Vasta et al. (2011)

Our Chemical Origins

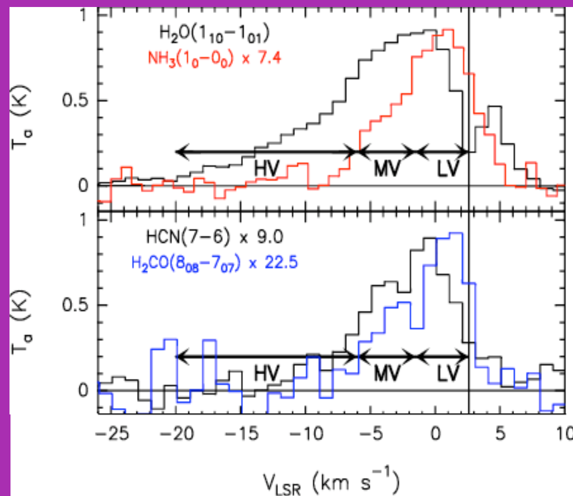


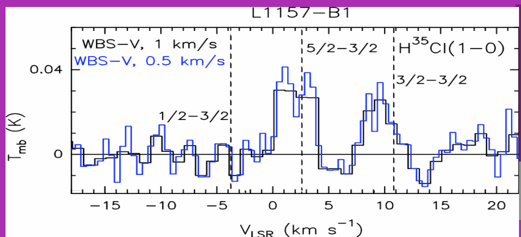
CHESS: Herschel Key Project
+ IRAM 30-m

A forest of lines



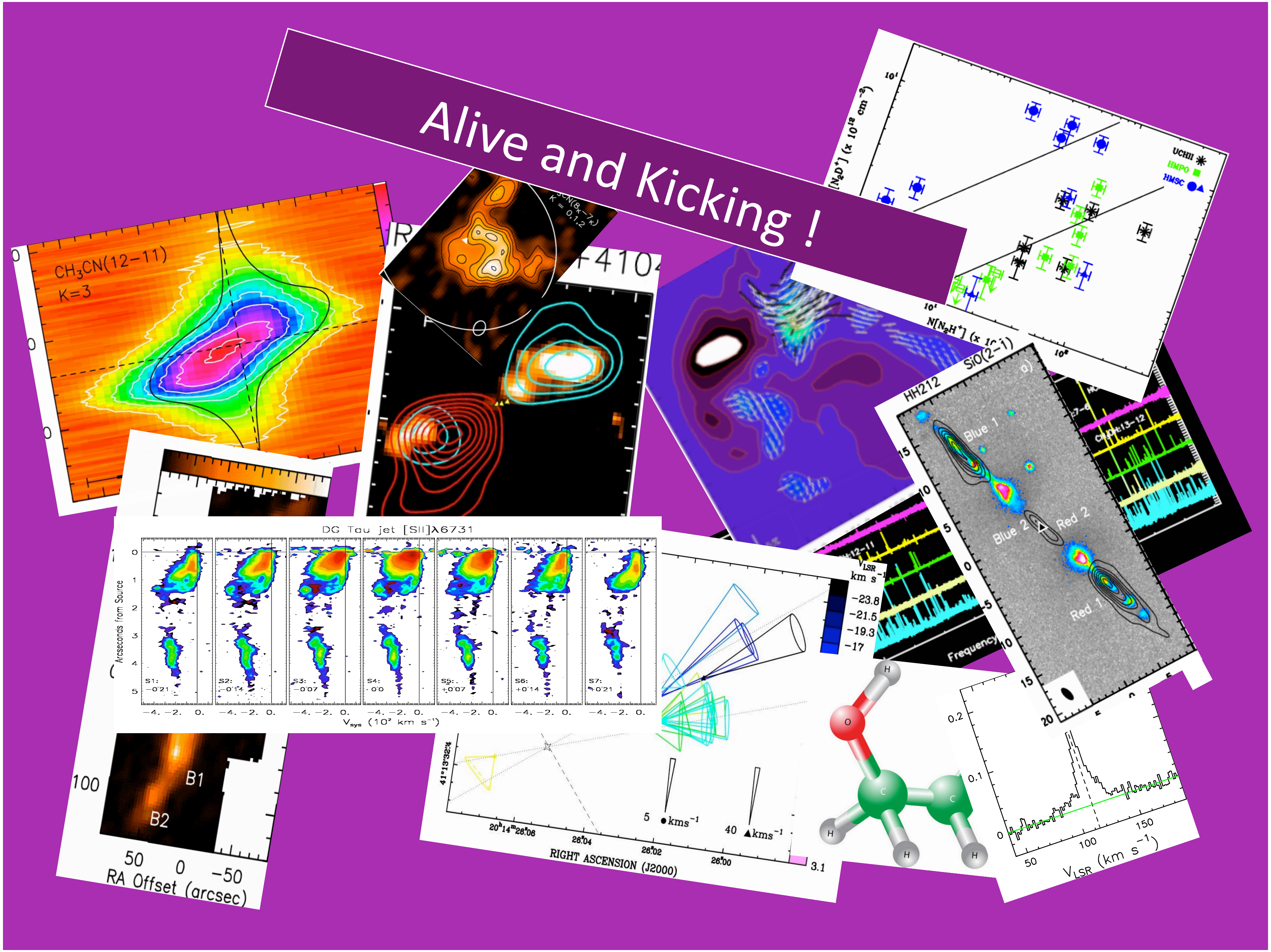
Unbiased spectral surveys of protostellar environments: excitation





Detailed analysis of the chemical compositions (e.g. first detection of HCl)

Codella et al. (2012)


Alive and Kicking !
CH3CN(12−11)
K=3
DG Tau jet [SII]λ6731
Arcseconds from Source
Vsys (10² km s⁻¹)
S1: −0.21
S2: −0.14
S3: −0.07
S4: 0.0
S5: +0.07
S6: +0.14
S7: +0.21
B1
B2
RA Offset (arcsec)
UCHII
HMPO
HMSC
HH212
SiO(2−1)
Blue 1
Blue 2
Red 2
Red 1
Frequency
RIGHT ASCENSION (J2000)
5 kms⁻¹
40 kms⁻¹
VLSR (km s⁻¹)