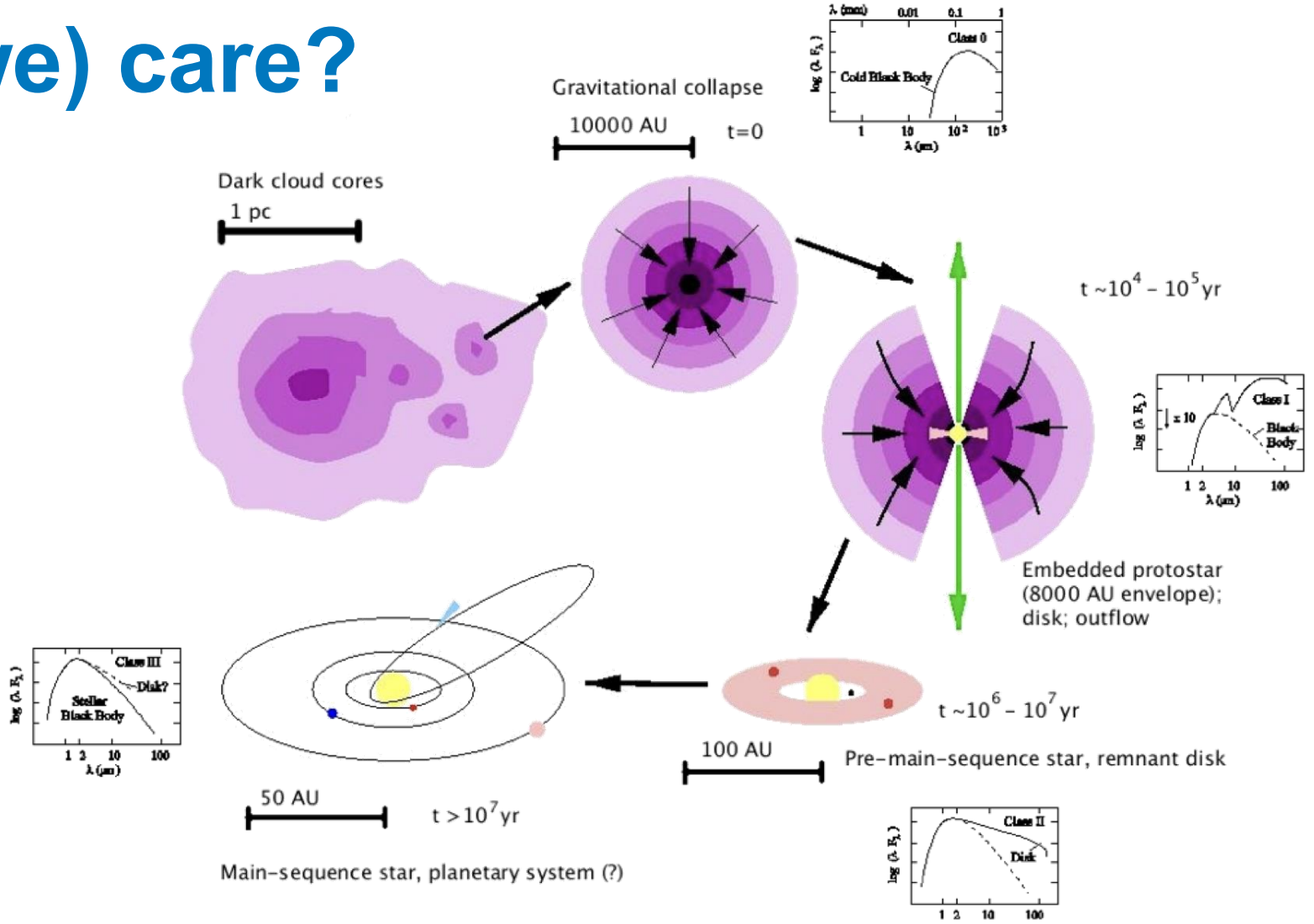
Young isolated planetary mass objects: then and now

With Thomas' contributions all the way!

IPMOS, FFPMOs, JuMBOs, why do I (we) care?

Thermal Jeans mass
in molecular clouds
~1 M⊙

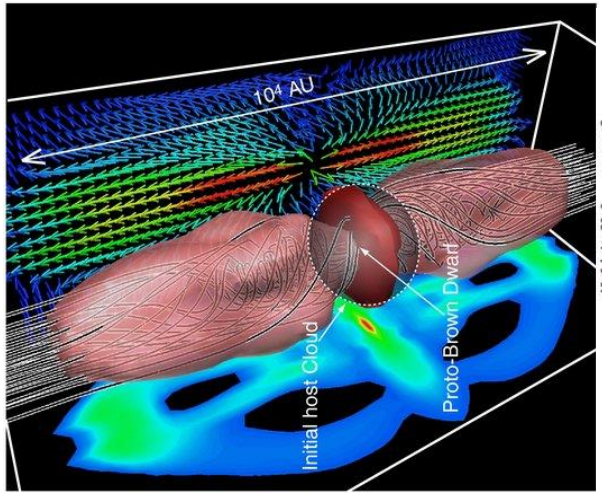
Something “fishy”!

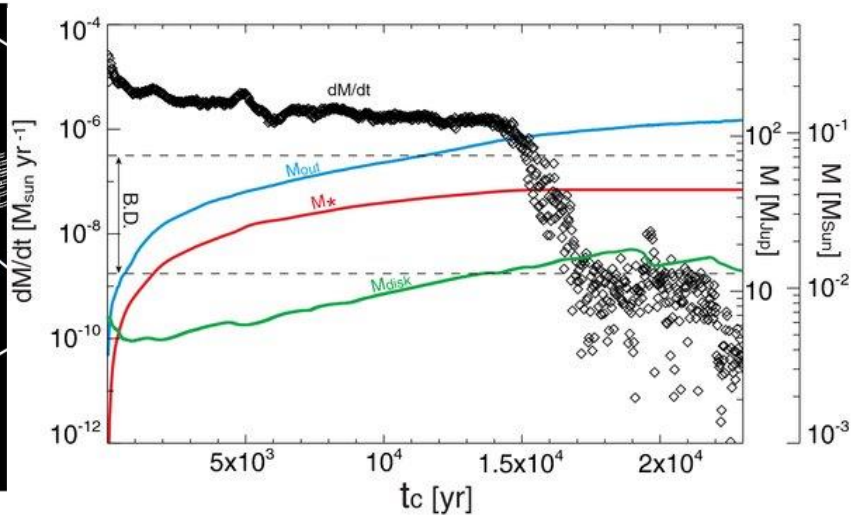


How do we make this work? “À la failed or special star”

How do we make this work? “À la failed or special star”

Turbulent fragmentation
(*Padoan & Nordlund, 2002; Hennebelle & Chabrier, 2008*):
density enhancements → decrease the Jeans mass
(also filament collapse, Inutsuka & Miyama 1992)





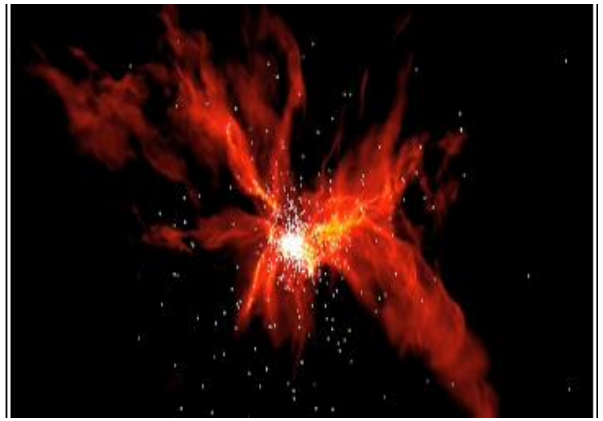
Sharp decline in Ṁ:
- large mass fraction ejected by protostellar outflow
- thermal pressure → gas escapes from the host cloud

Photoevaporation

(*Whitworth & Zinnecker 2004*)

Ejection scenario

(*Reipurth & Clarke 2001, Umbreit et al. 2005*)



Thomas likes theory

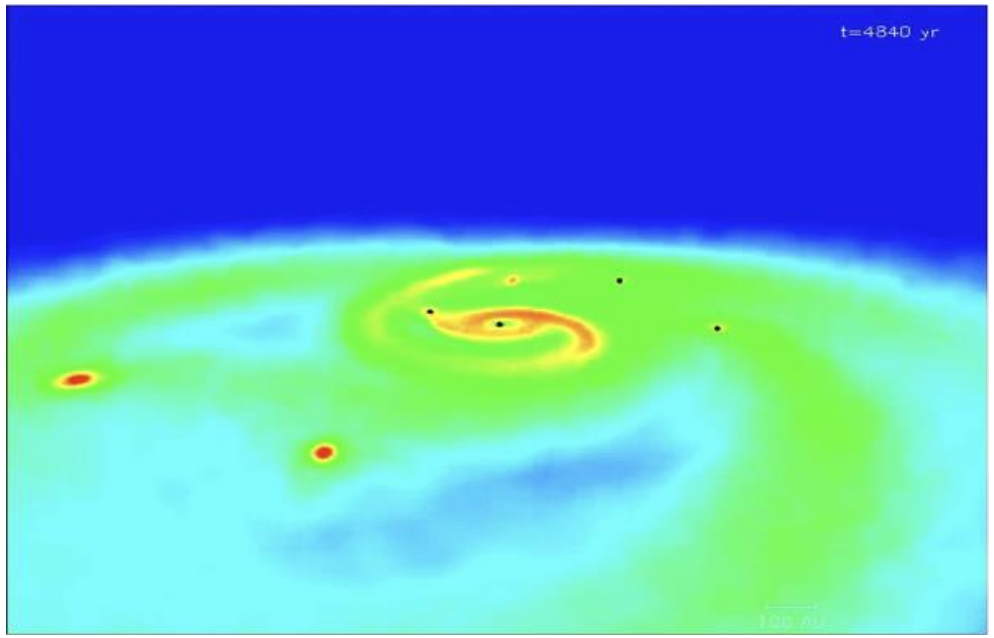
How do we make this work? “À la planet”

1.- Turbulent fragmentation / filament collapse

2.- Erosive outflows

3.- Photoevaporation

4.- Cluster / multiples dynamical ejection



Disk fragmentation

(*Goodwin & Whitworth, 2007; Stamatellos et al. 2007; Stamatellos & Whithworth 2009*)

Addressing environmental context: Building IMFs then…

Elephants in the room:
The membership
The statistics
The models

Addressing environmental context: Building IMFs then…

Elephants in the room:
The membership
The statistics
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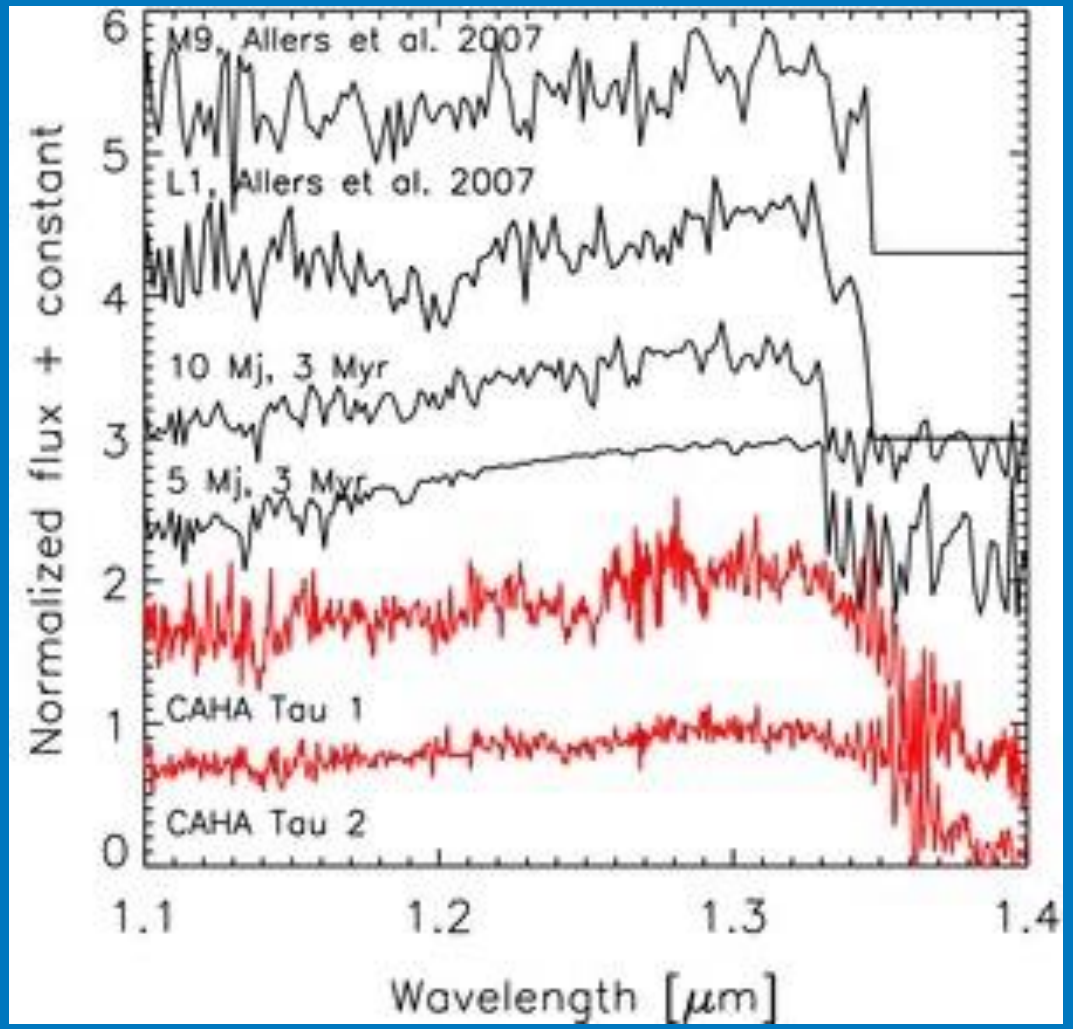

Quanz+2009

Addressing environmental context: Building IMFs then…

Elephants in the room:
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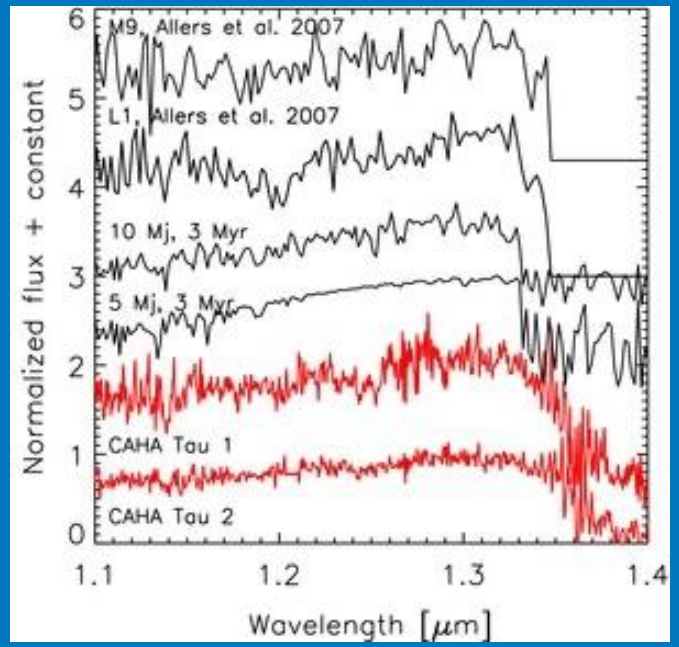
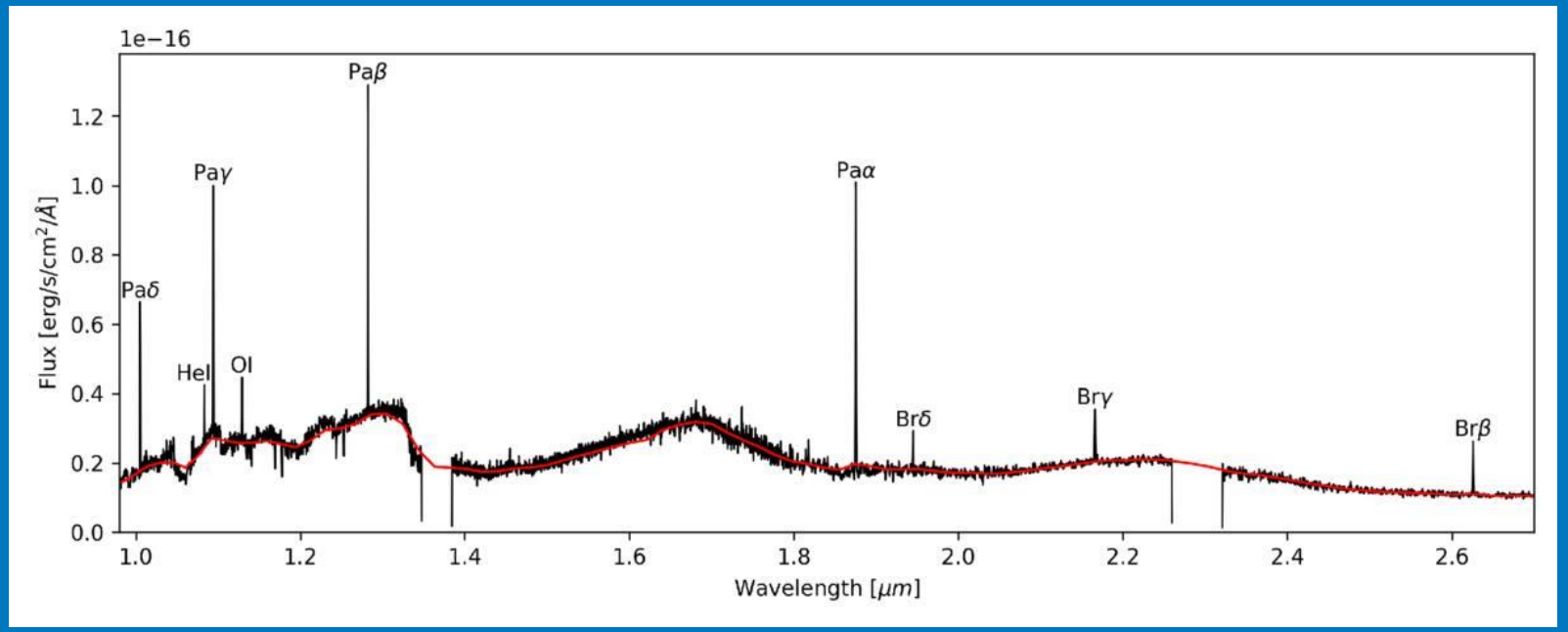
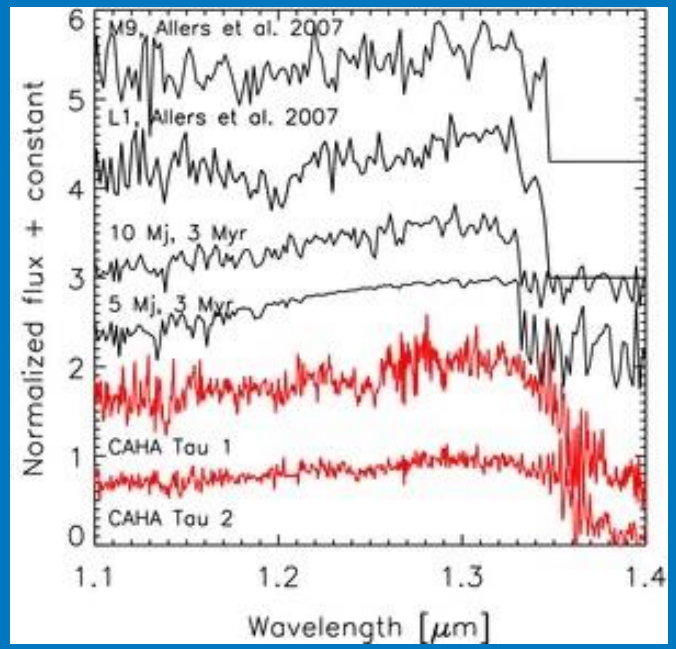


Quanz+2009



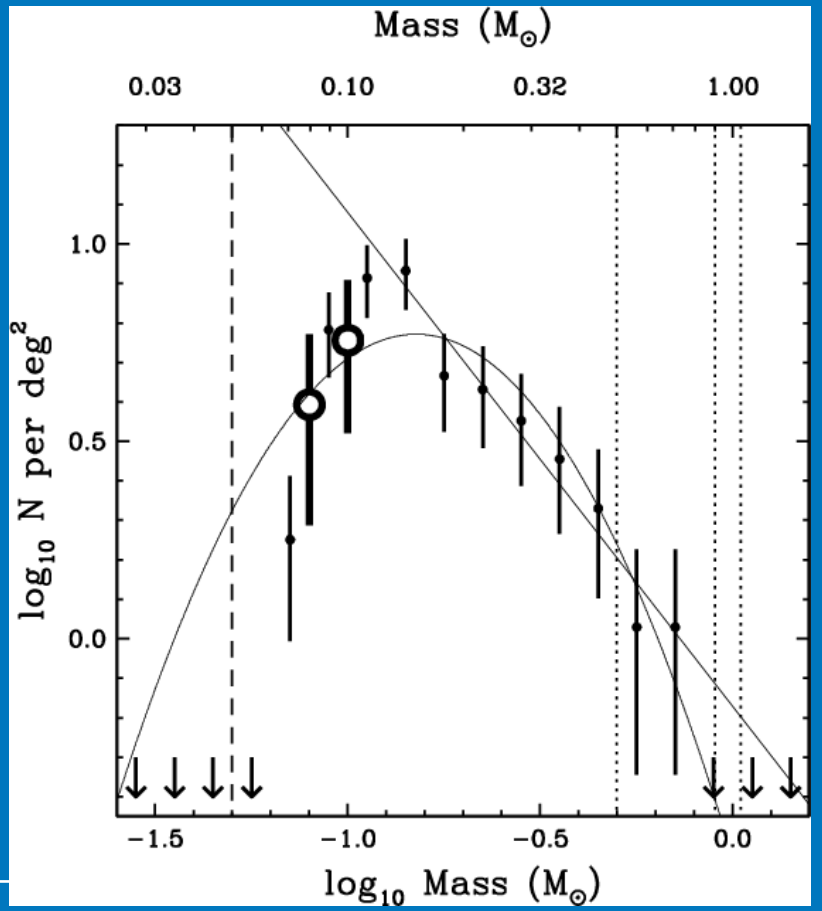
Almendros-abad+2025 (foreshadowing.. It is too easy now! ;-))

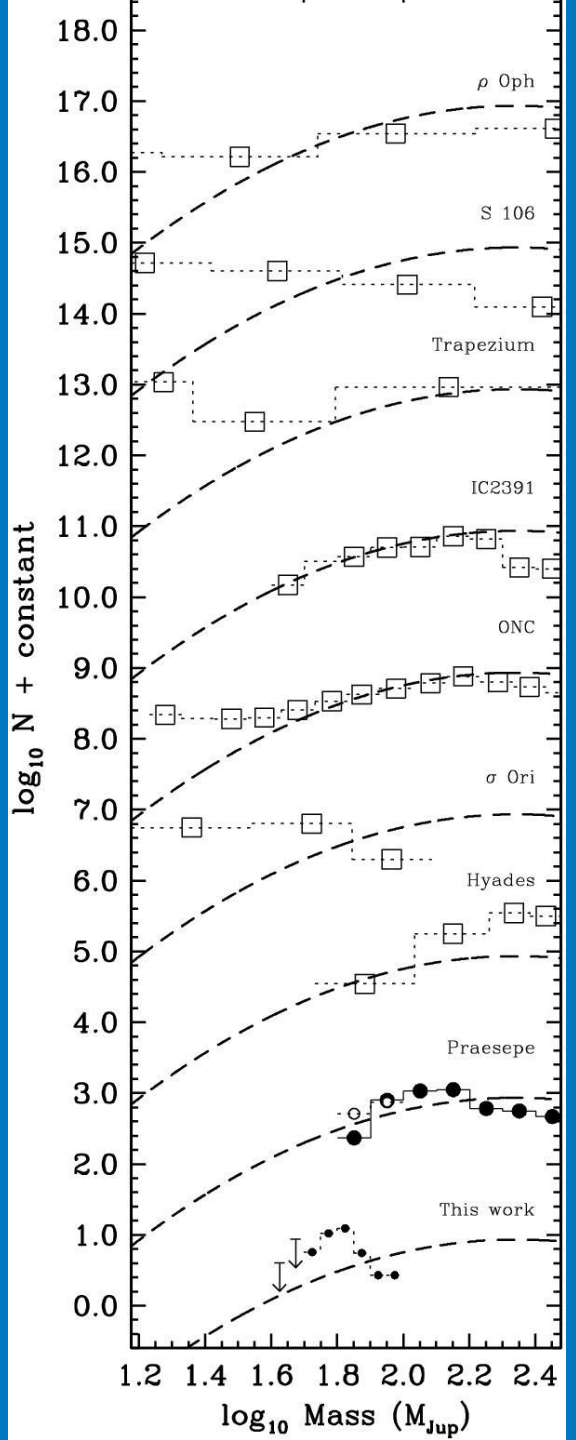
Addressing environmental context: Building IMFs then…



Quanz+2009

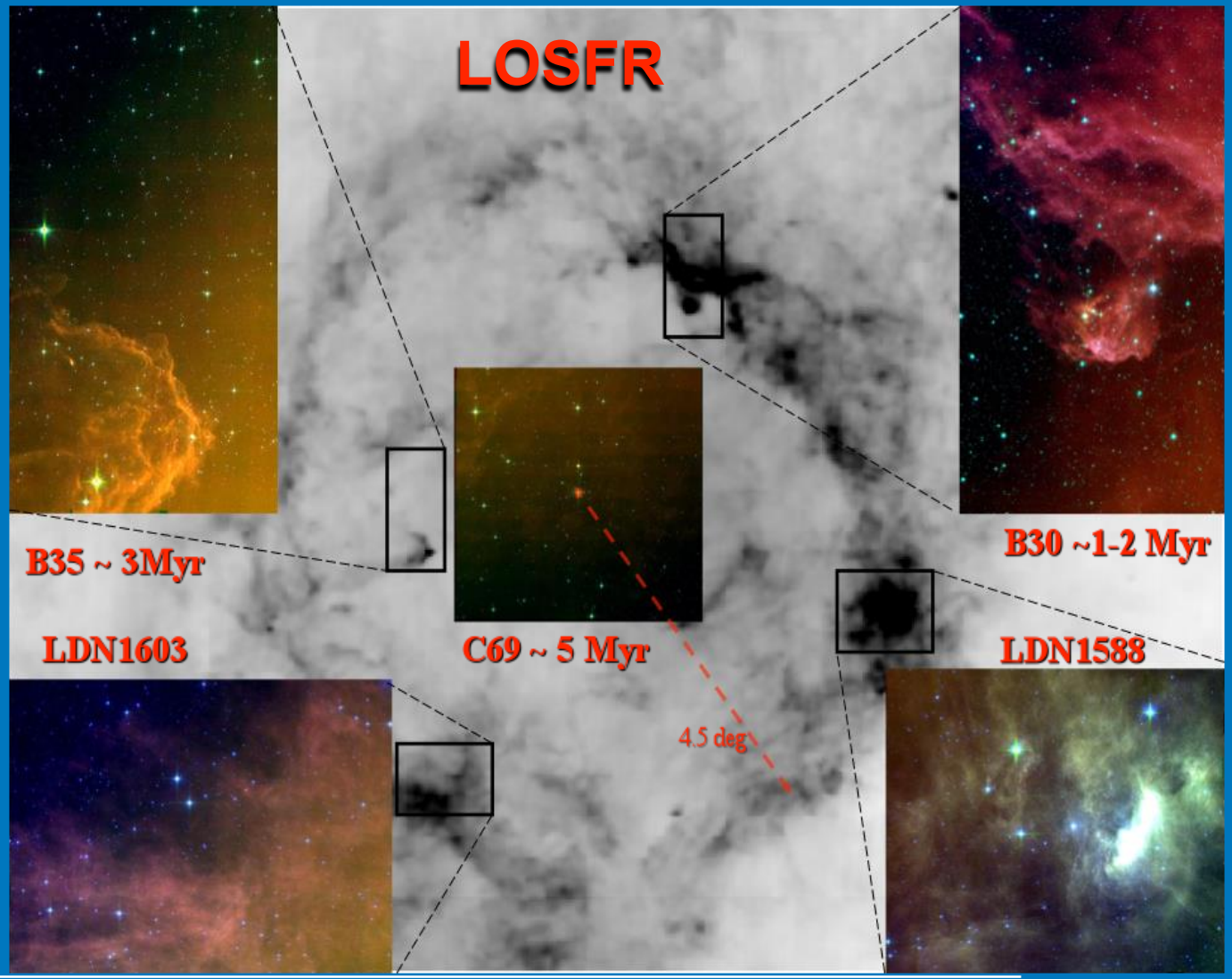
Praesepe IMF: dyn evol, binaries?
Boudreault+2010

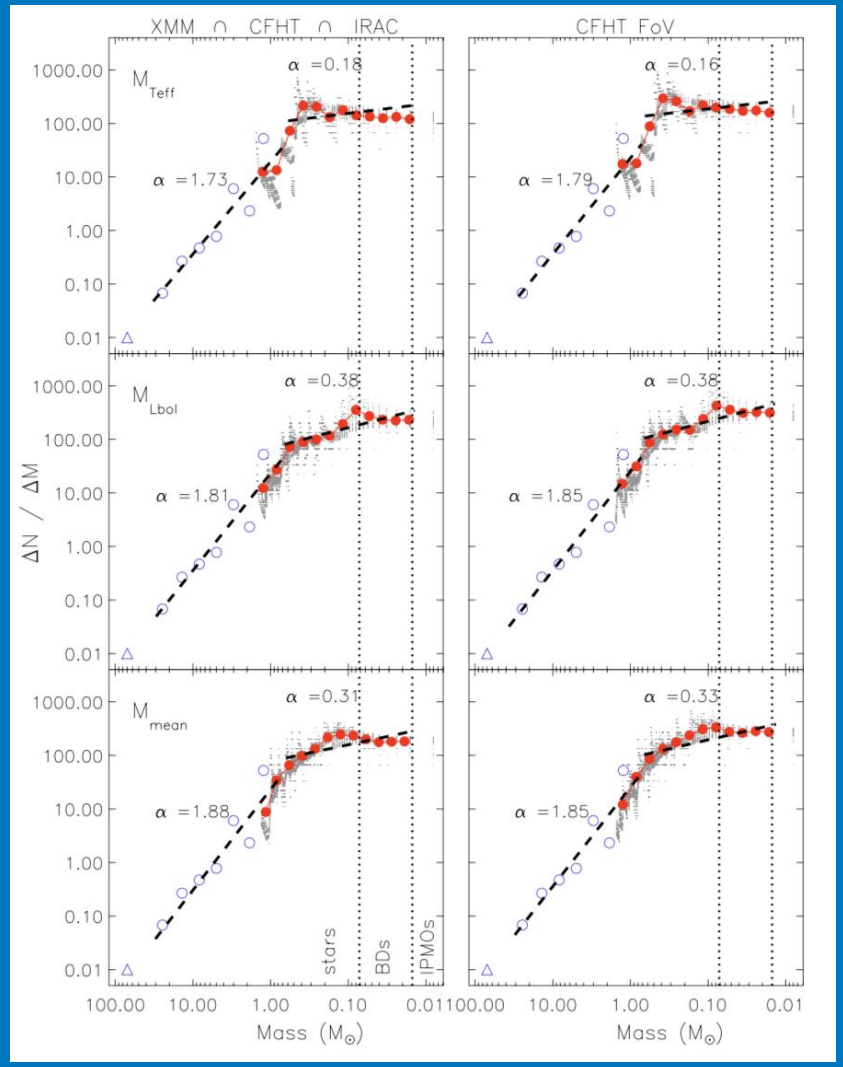




Addressing environmental context: Building IMFs… story time…

Elephants in the room:
The membership
The statistics
The models





Bayo+2011

Addressing environmental context: Building IMFs and now?

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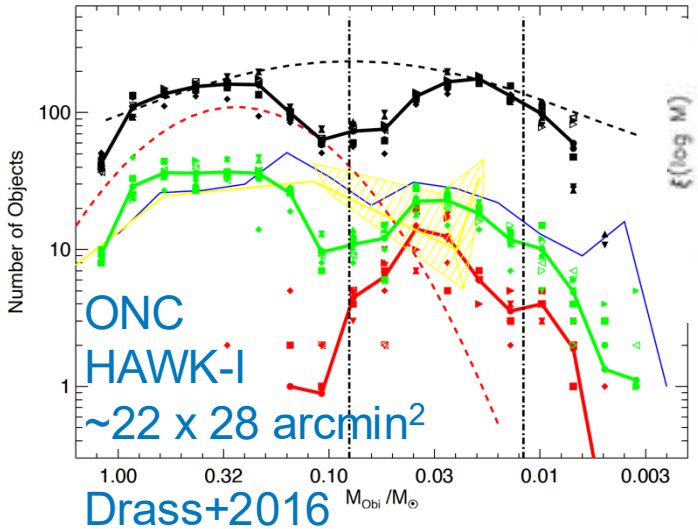
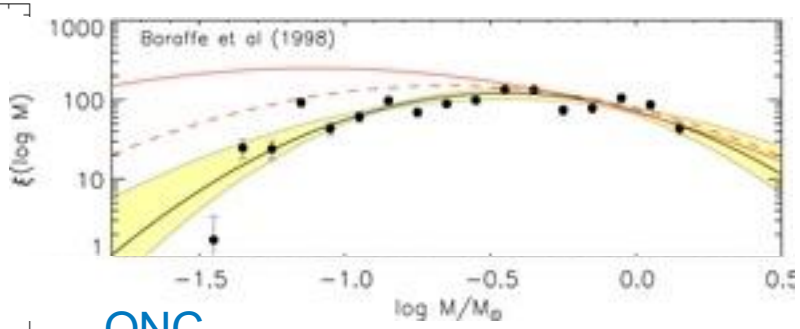
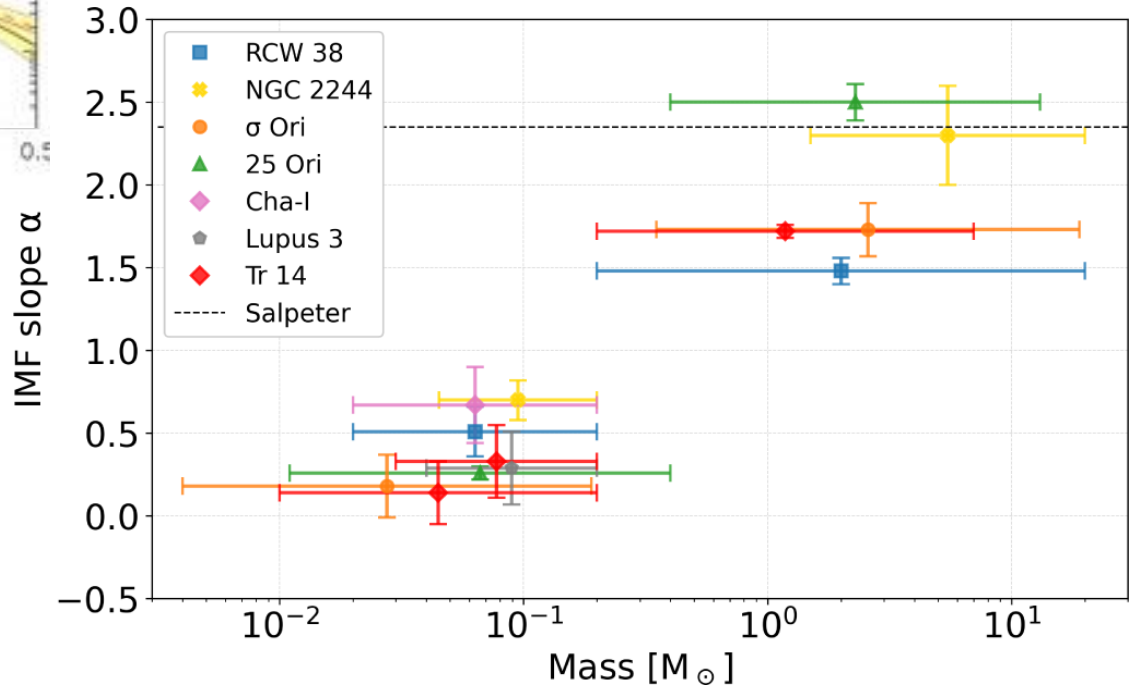
The membership
The statistics
The models



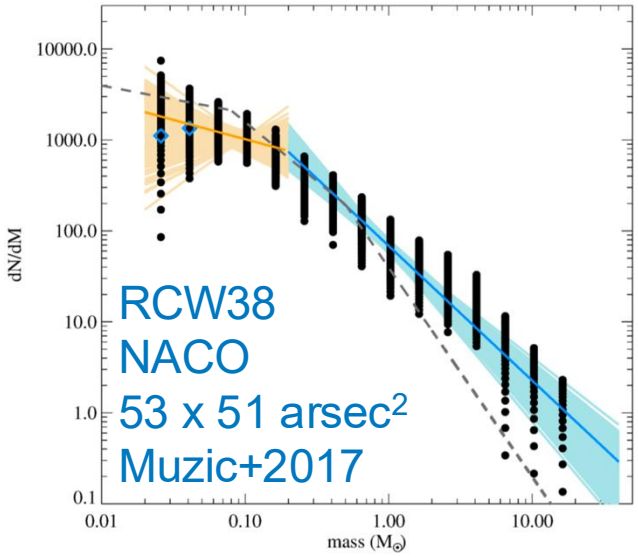
ONC
HAWK-I
~22 x 28 arcmin^2
Drass+2016



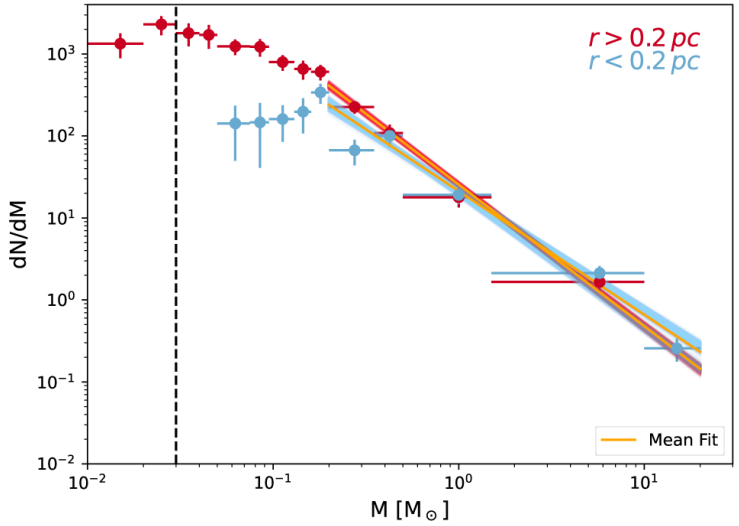
ONC
WFI 2.2m
~32 × 33 arcmin^2
daRio+2012



Rom+2025



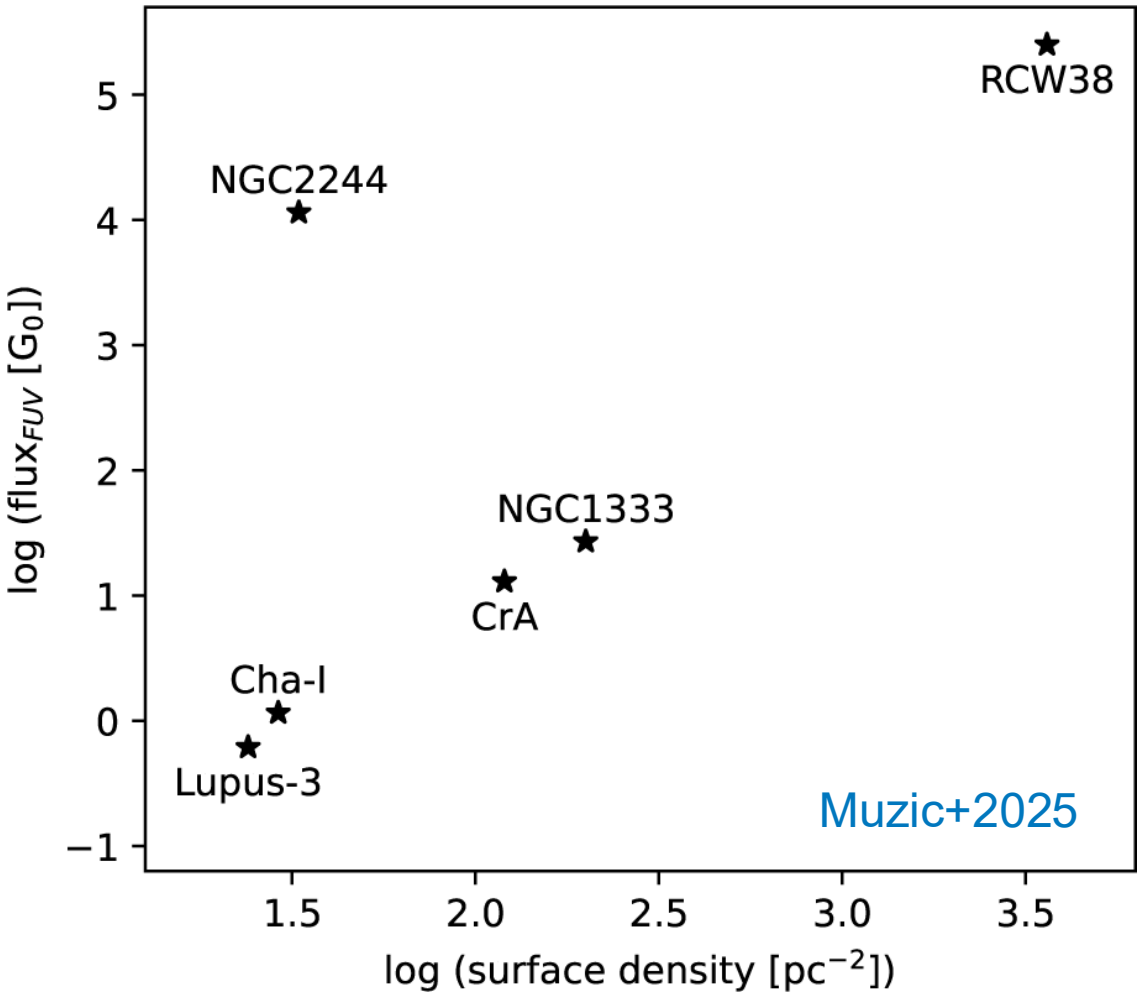
RCW38
NACO
53 x 51 arsec^2
Muzic+2017



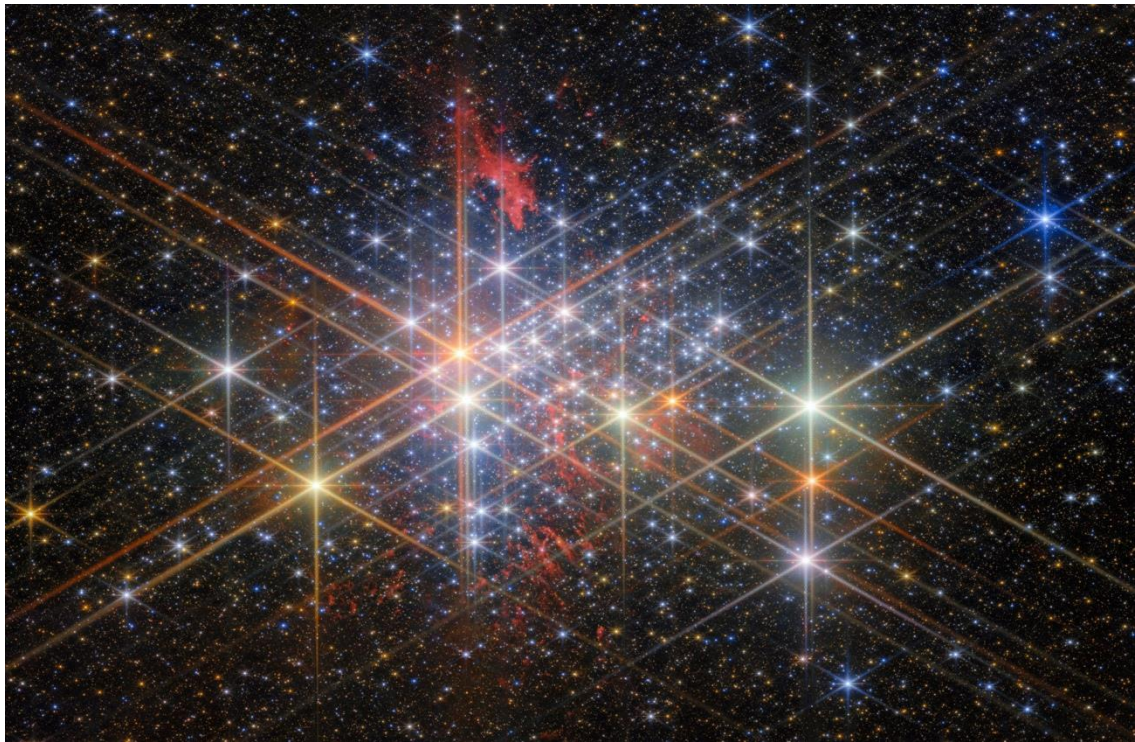
RCW38
HAWK-I (GRAAL)
7.5 x 7.5 arcmin^2
do Brito do Vale+2016

Addressing environmental context: Building IMFs and now? … TBC!

Elephants in the room:
The membership
The statistics
The models



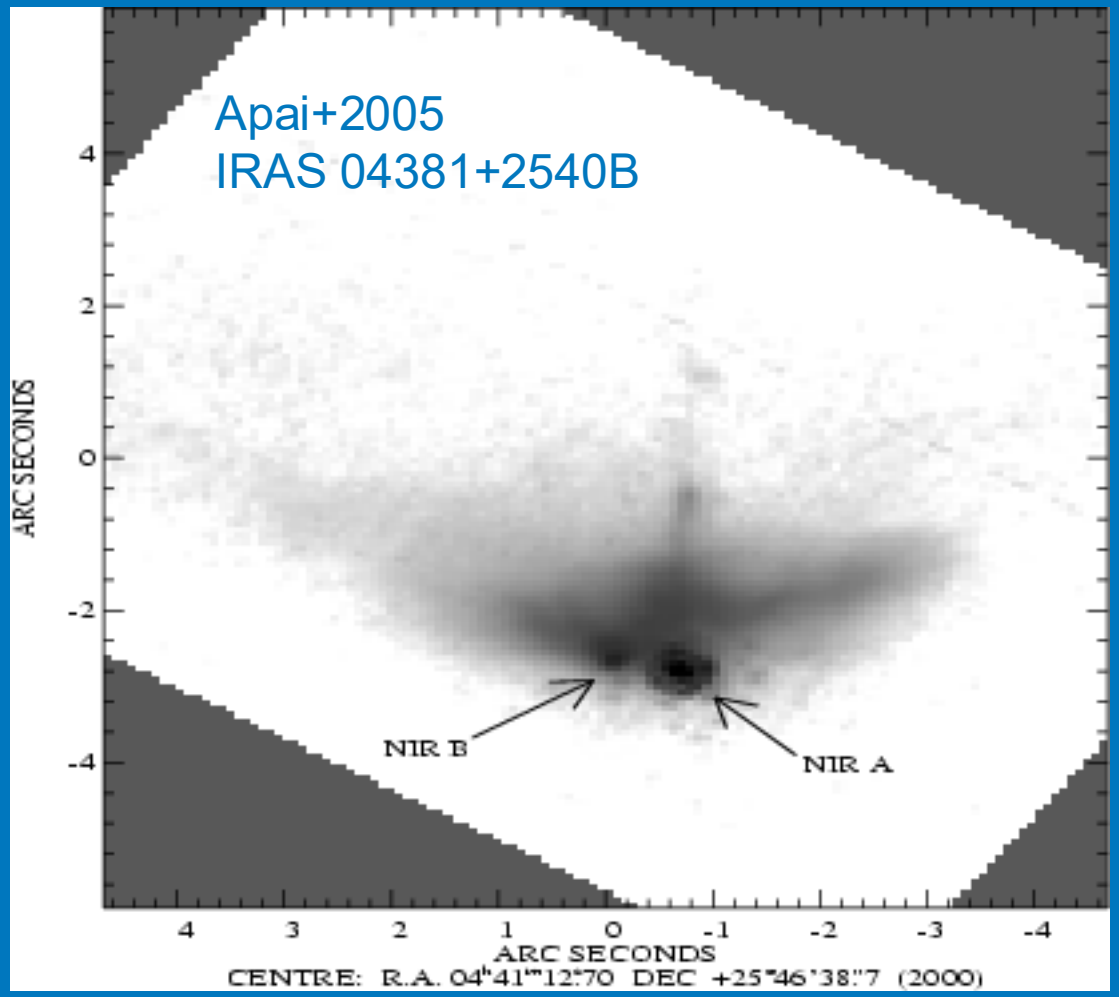
PI Guarcello
Wd1 & Wd2
Chandra/ACIS-I
JWST/MIRI & NIRCam
VVVX, ….



Get them at the earliest stages:

Elephants in the room:
Grav. Bound
The total mass
Sensitivity!

Get them at the earliest stages:



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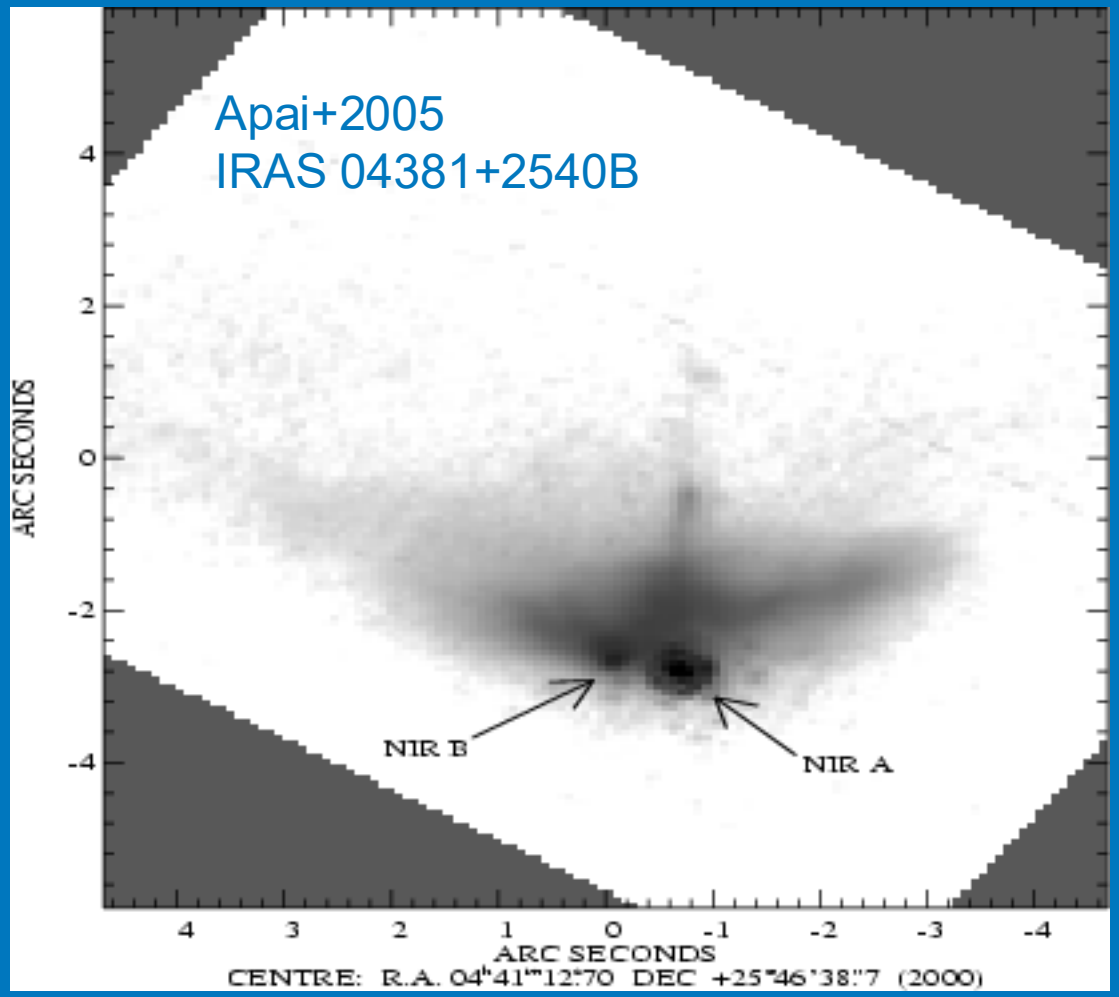

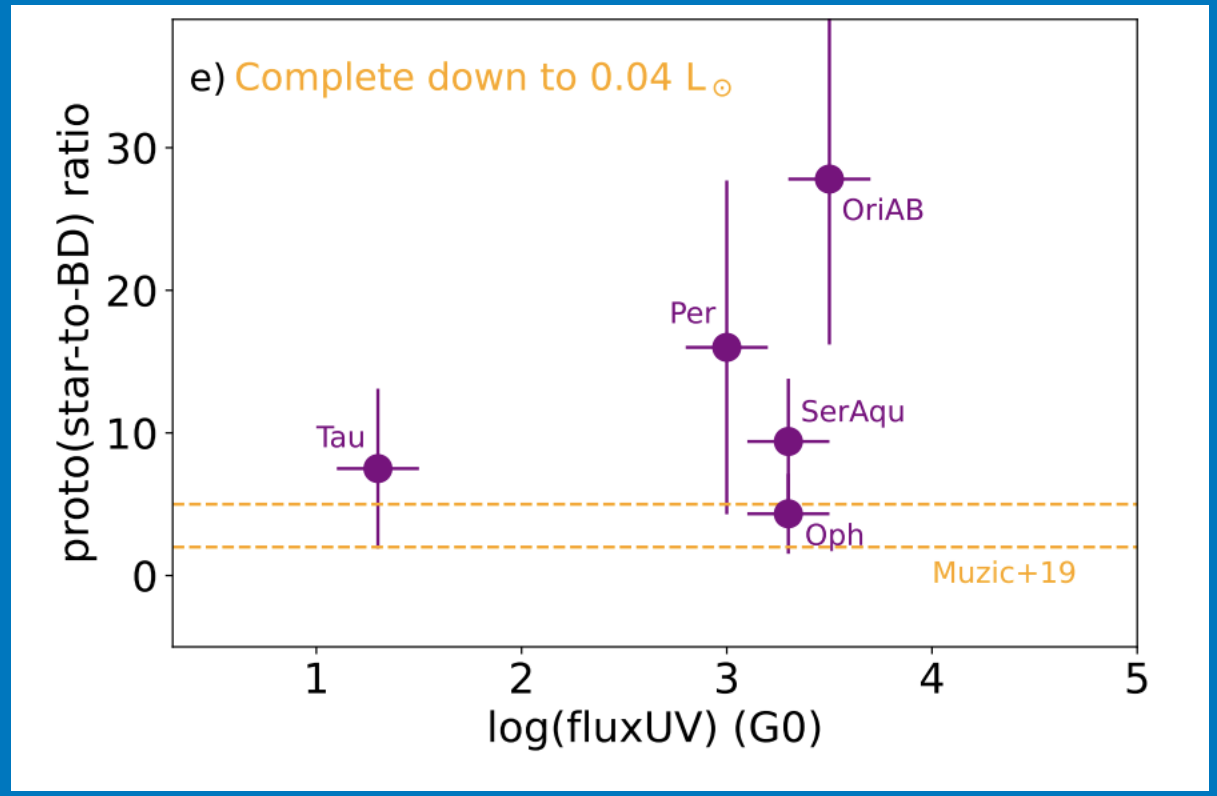

Palau+2024
Deserves a talk on its own… moving on!

Ok… get them later on?

Elephants in the room:
Census
Accretion
Sensitivity!

Klein+2003
CFHT-BD-Tau 4 & IC 348 613
FIRST DETECTION OF MILLIMETER DUST EMISSION FROM BROWN DWARF DISKS

log νF_ν (Wm^{-2})

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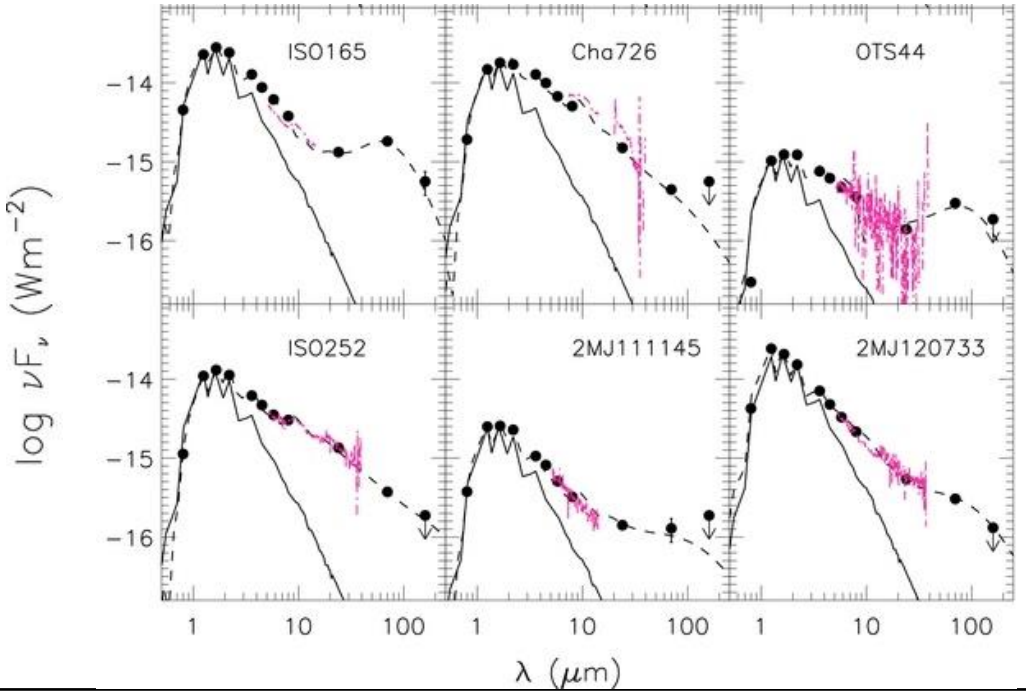
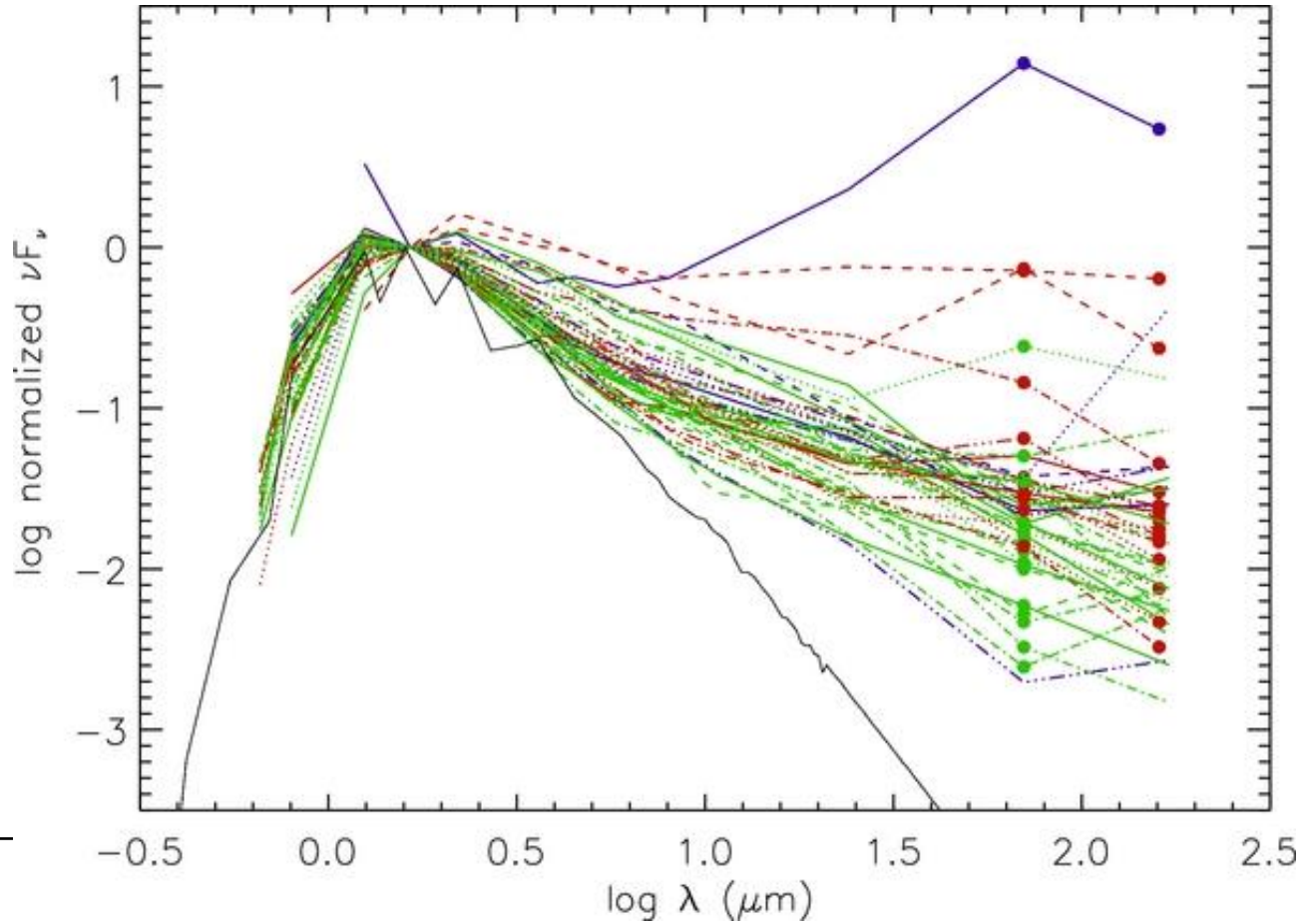
Harvey+2012
50 targets (VLMs/BDs, Oph, Tau, Cha I,…)





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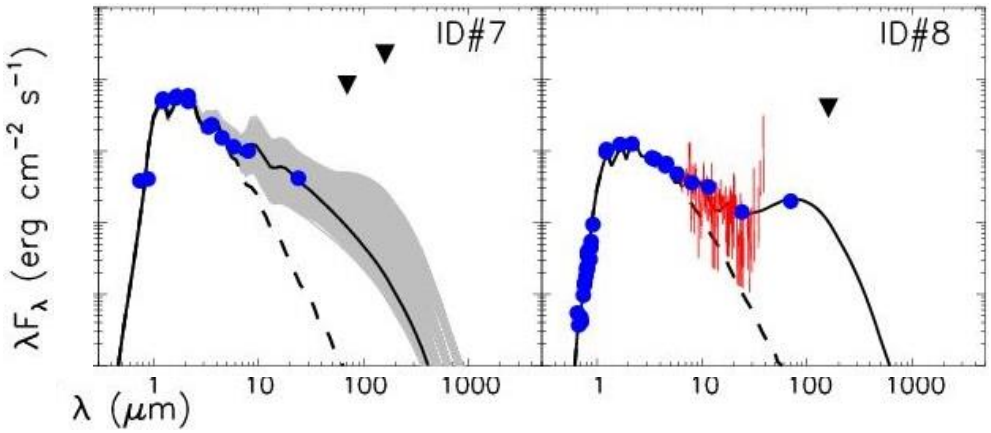
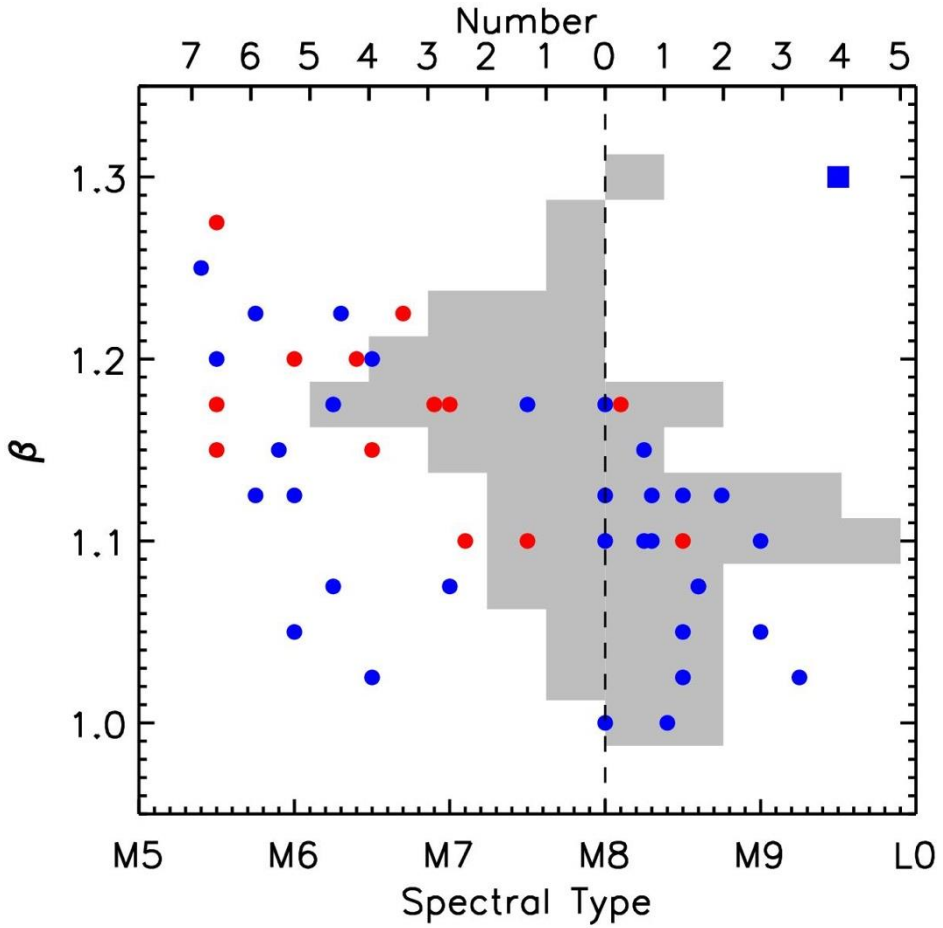
Harvey+2012
50 targets (VLMs/BDs, Oph, Tau, Cha I,…)

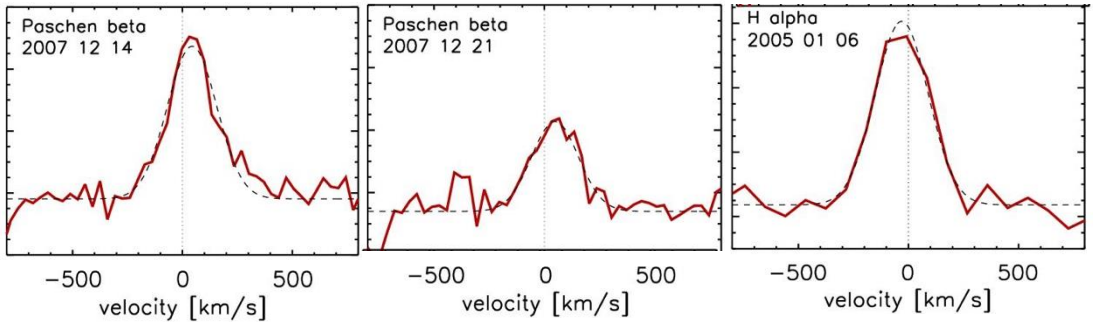
Liu+2015
Reanalysis of 47 targets…
aren't we all looking for correlations?... And weirdos!

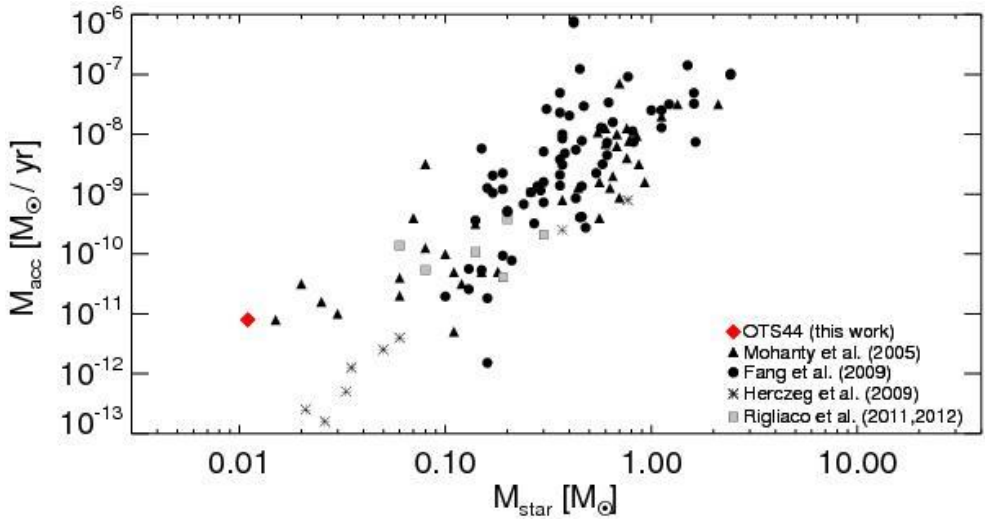




Ok… get them later on?

Joergens+2013
OTS 44 accretion at the planetary border…

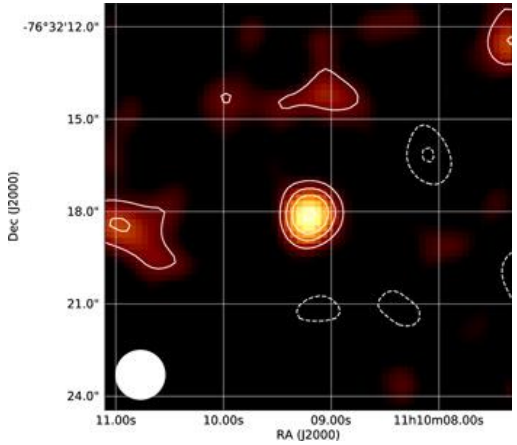


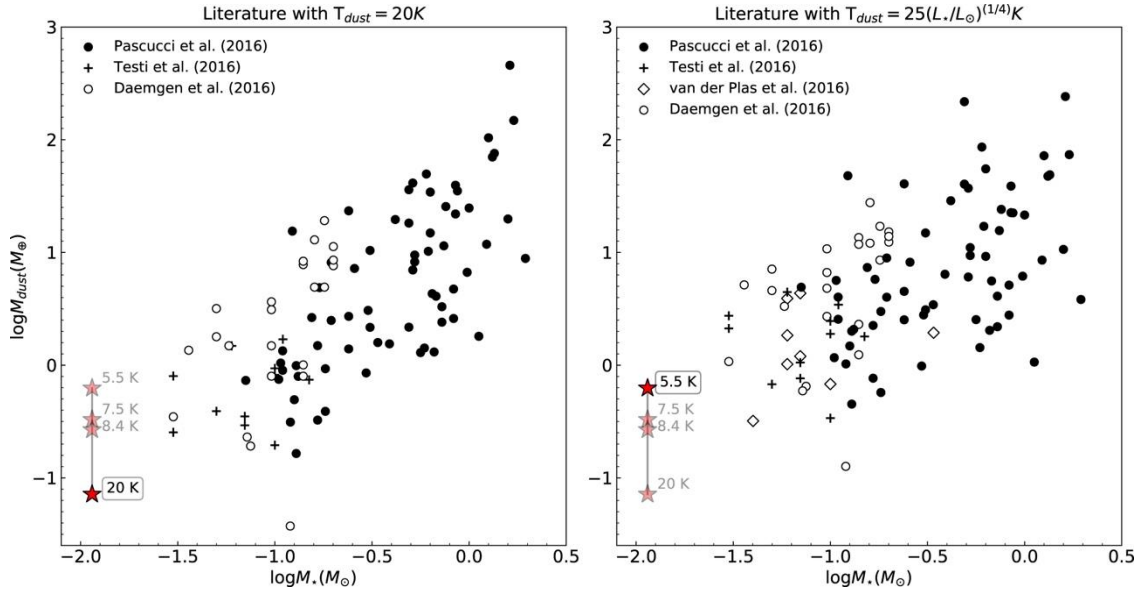


Elephants in the room:
Census
Accretion
Sensitivity!

Bayo+2017
… pushing mm detection

additional modeling with
2 ALMA bands (+ up lim)
-> grain growth





Ok… get them later on?

Elephants in the room:
Census
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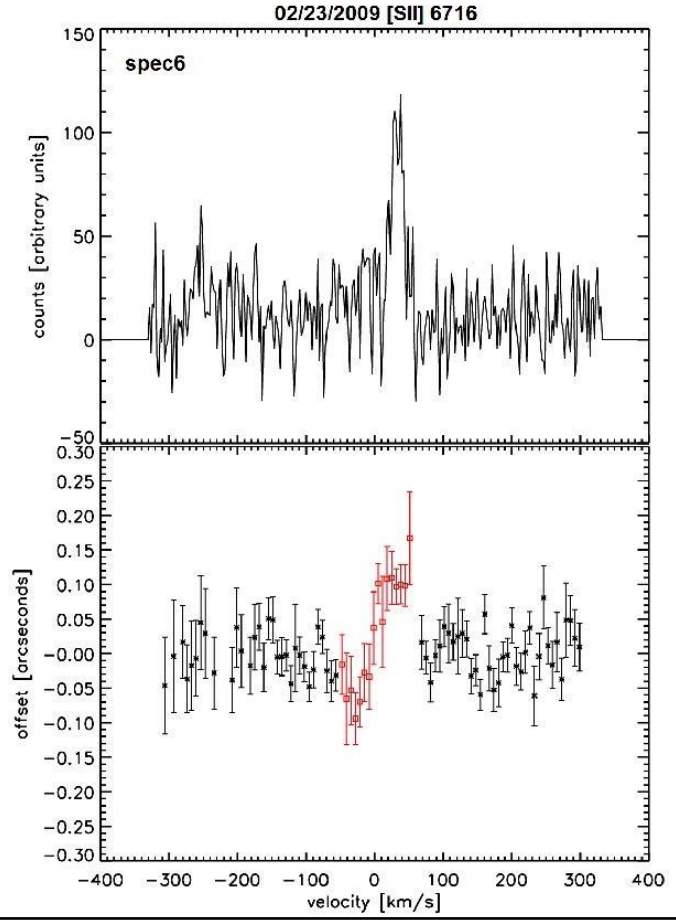
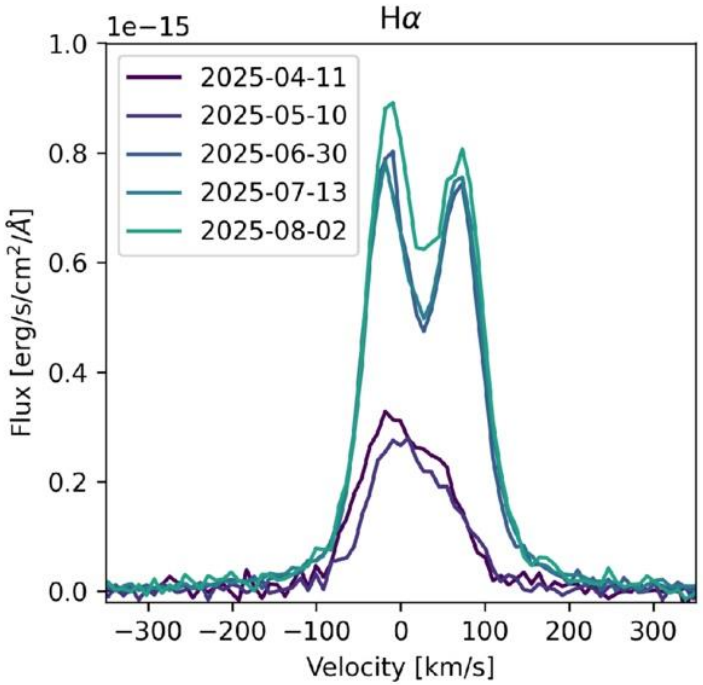
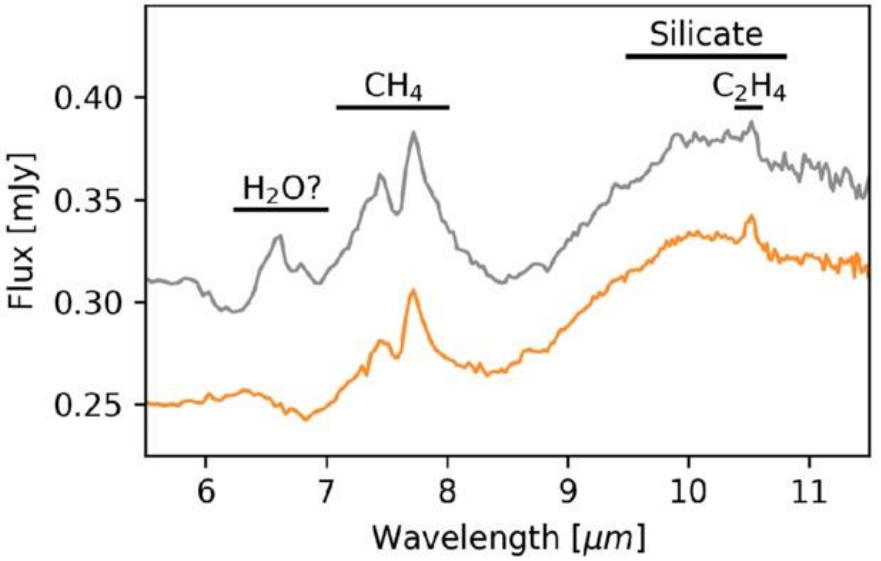
Sensitivity!

Joergens+2012
Outflow in ISO 217



Almendros-Abad+2025
A bursting IPMO!





And so much more I could not cover:

fast rotation (e.g. Biller+2015)

patchy clouds (e.g. Chen+2025)

surface reconstruction(e.g. Crossfield+2014)

…

…

Thank you!

Thank you Thomas for your continuous enthusiasm and leadership in trying to understand these fascinating objects!

@ESOAstronomy
@esoastronomy
@ESO
european-southern-observatory
@ESOobservatory

No chance… wait…

JWST Spectra of Brown Dwarf Candidates in the Orion Nebula Cluster

K. L. Luhman[1,2]★
[1]*Department of Astronomy and Astrophysics, The Pennsylv*
[2]*Center for Exoplanets and Habitable Worlds, The Pennsy*

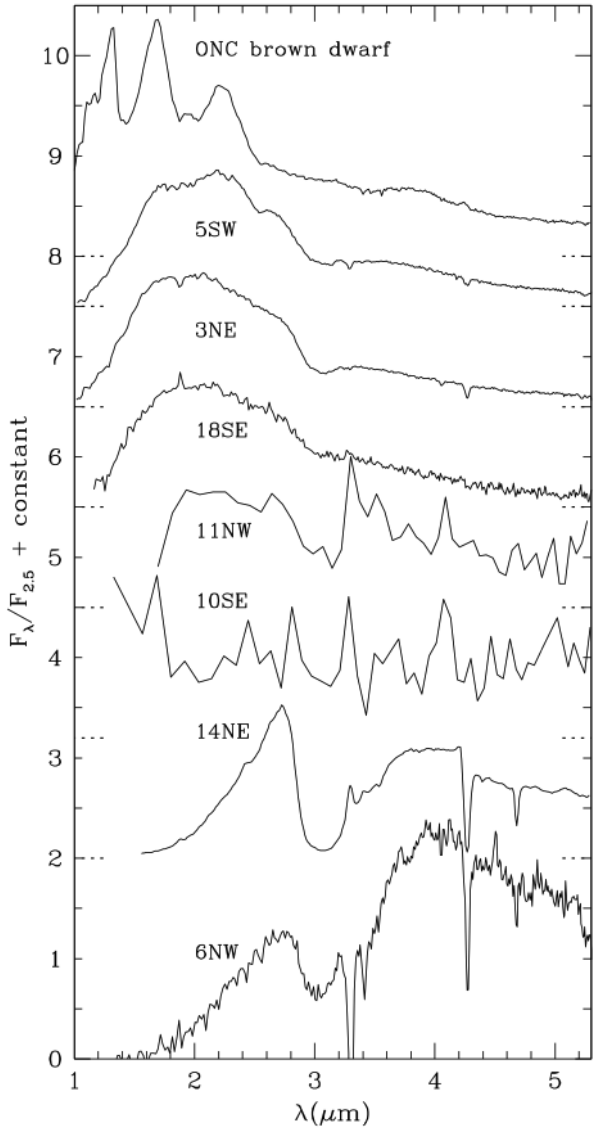
Accepted XXX. Received YYY; in original form ZZZ

"The photometry suggested that only one promising substellar binary is present among the JuMBOs, and that its components do not approach the mass of Jupiter".

ABSTRACT

I present an analysis of archival spectra of 200 sources toward the Orion Nebula Cluster (ONC) that were obtained with the Near-Infrared Spectrograph (NIRSpec) on board the James Webb Space Telescope (JWST). I have used these data to assess cluster membership and measure spectral types for the targets. Fifty-three sources are classified as likely cluster members, 24 of which have spectral types that are suggestive of brown dwarfs (>M6). Seven of the NIRSpec targets were previously identified as "Jupiter-mass binary objects" (JuMBOs), all of which are background sources rather than brown dwarfs based on the NIRSpec data. The spectral classifications of those objects are consistent with the results of my recent study of the JWST photometry in the ONC, which found that only a few JuMBO components have the colors expected for brown dwarfs, none of which form pairs that have uniquely wide separations or low masses relative to known binary brown dwarfs.

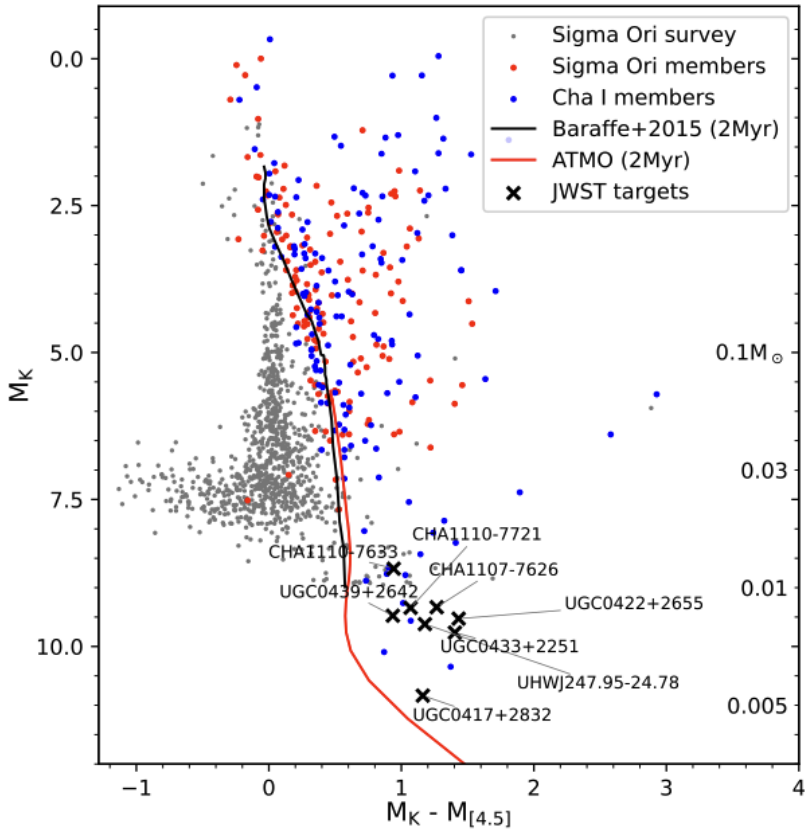
Key words: brown dwarfs – stars: formation

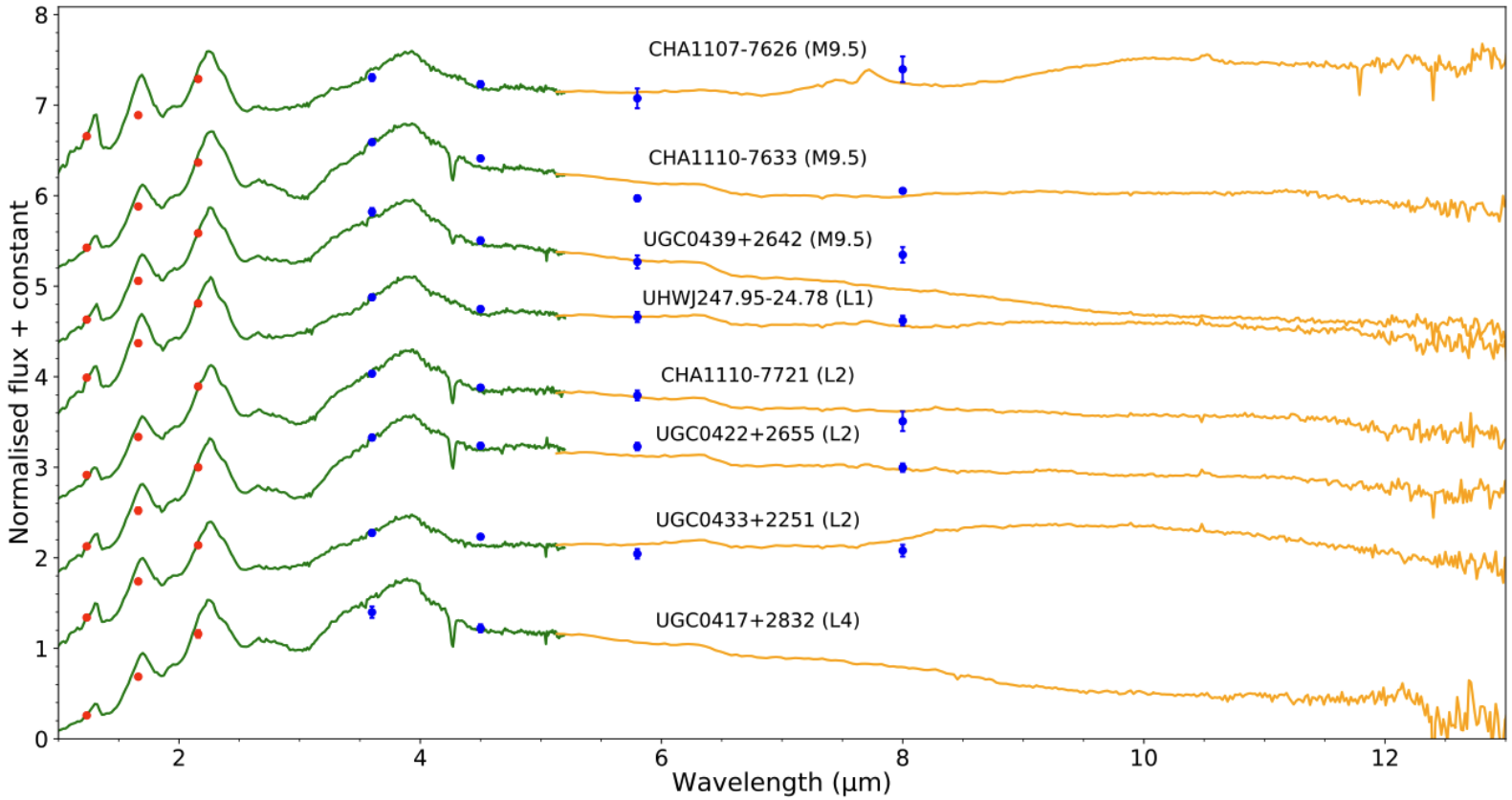


Desperate no more, JWST does observe IPMOs!

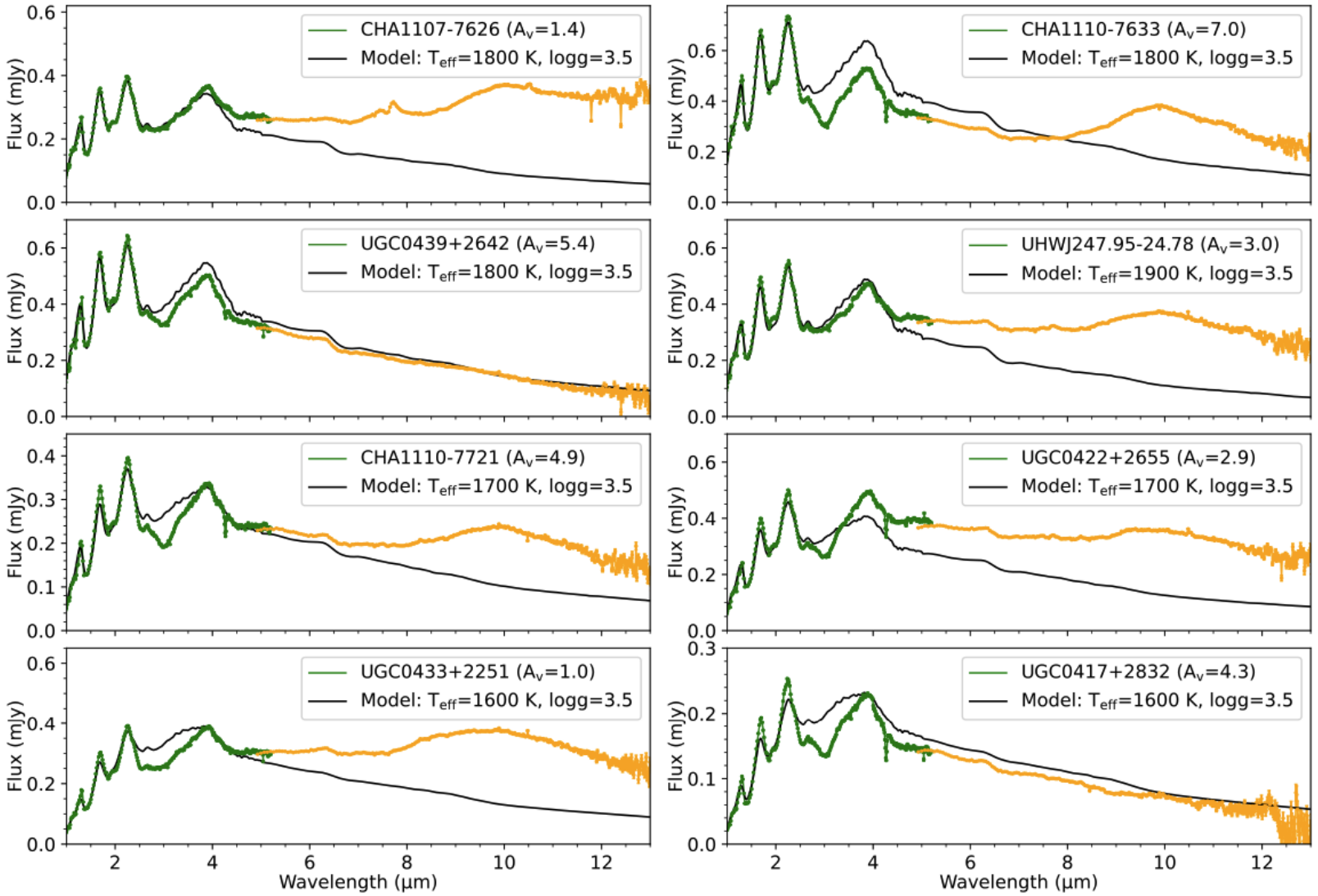
Spectroscopy of Free-Floating Planetary-Mass Objects and their disks with JWST

Belinda Damian [1], Aleks Scholz [1], Ray Jayawardhana [2], V. Almendros-Abad [3], Laura Flagg [2], Koraljka Mužić [4], Antonella Natta, [5] Paola Pinilla [6], and Leonardo Testi [7]

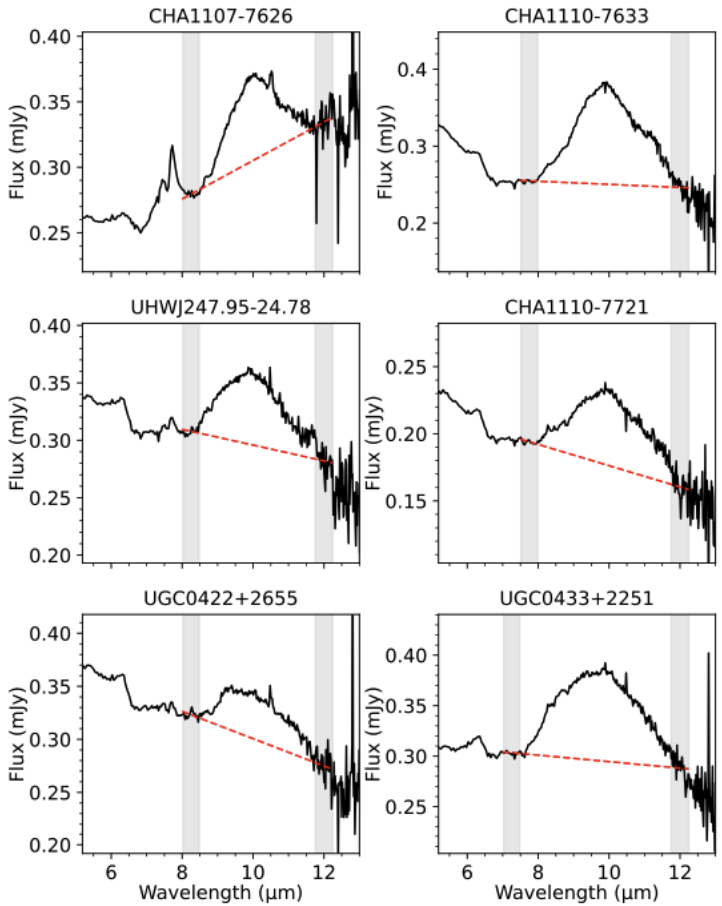




What can we learn from these spectra?



- SpT M9.5-L4
(Teffs 1600-1900 but models don't fit! Si clouds!)
- Six disks:
grain growth & crystaliz. ~ stars



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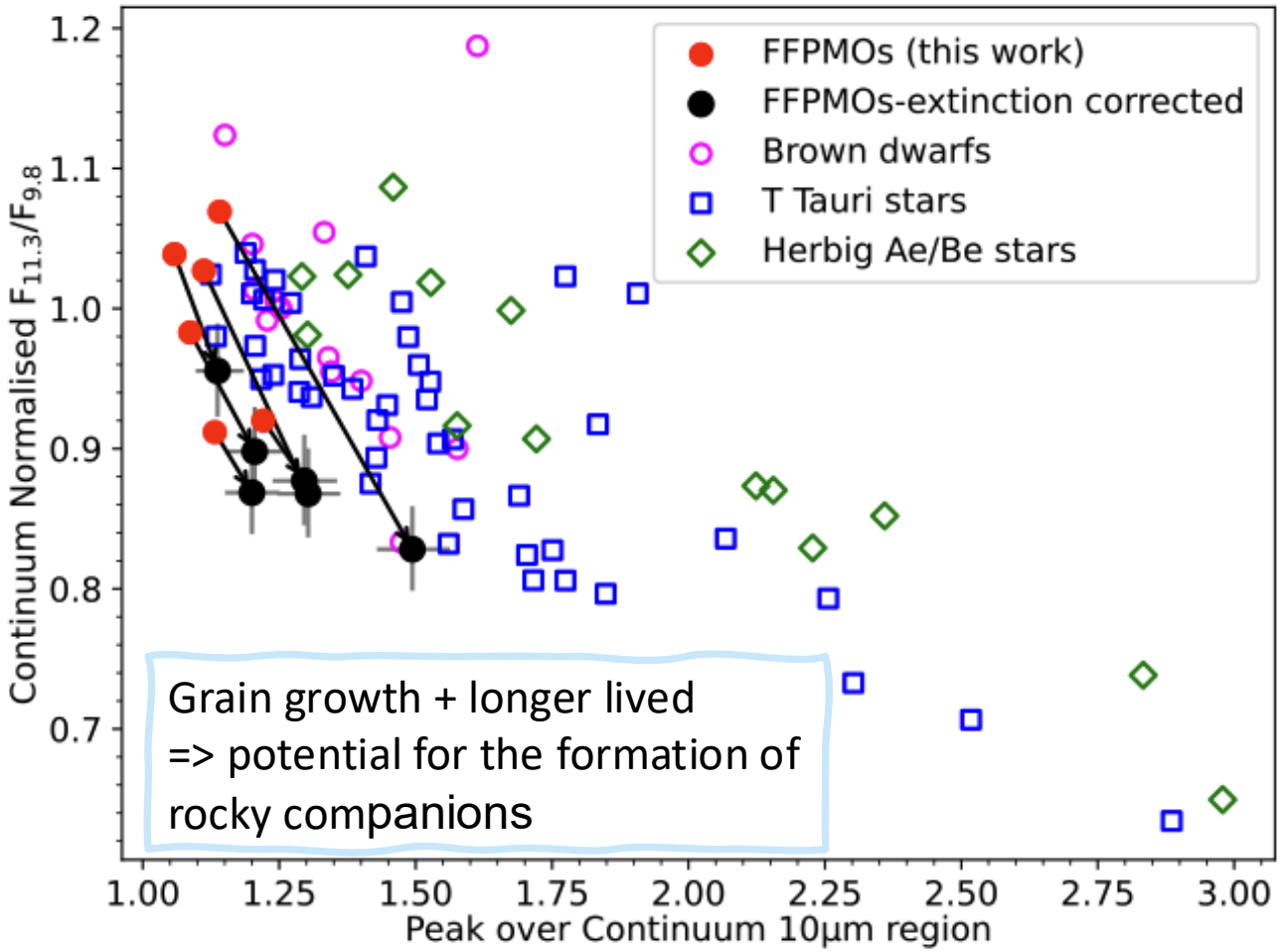

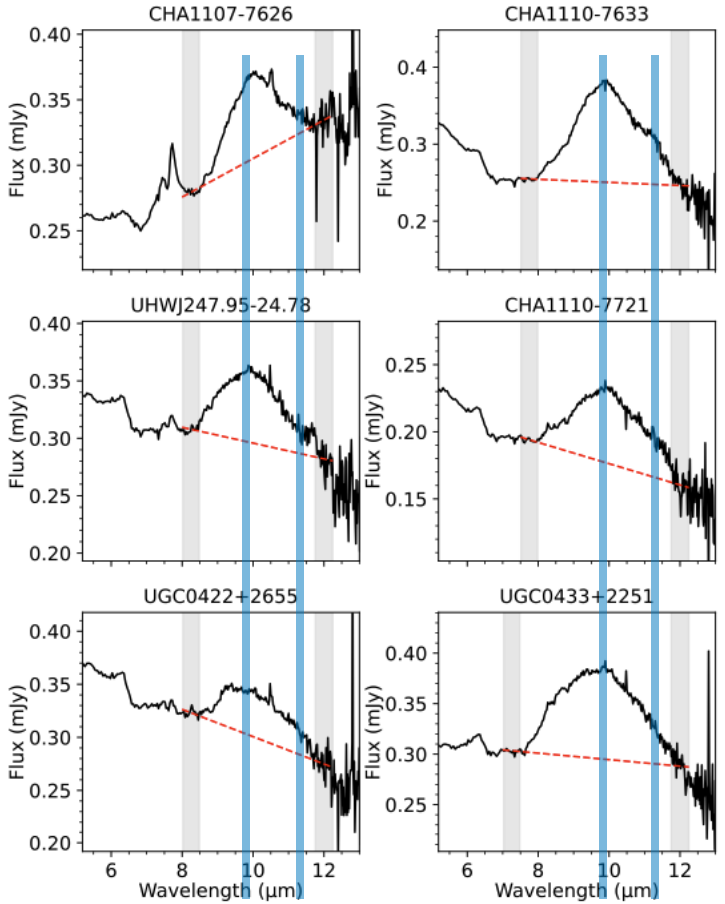

dereddened