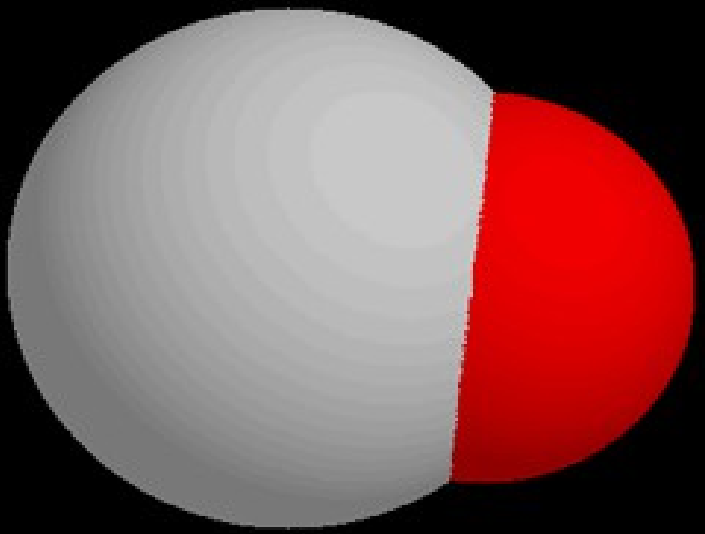
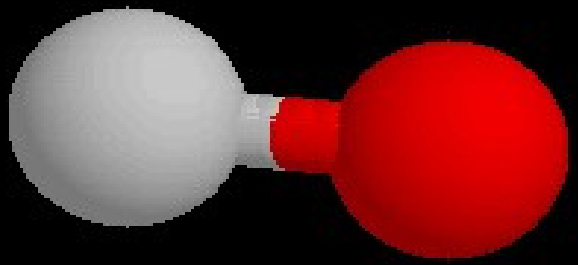
Warm CO gas as tracer of the inner 50 au of proto-planetary disks

CO





C=O

M. E. Van den Ancker
L. B. F. M. Waters
C. Dominik

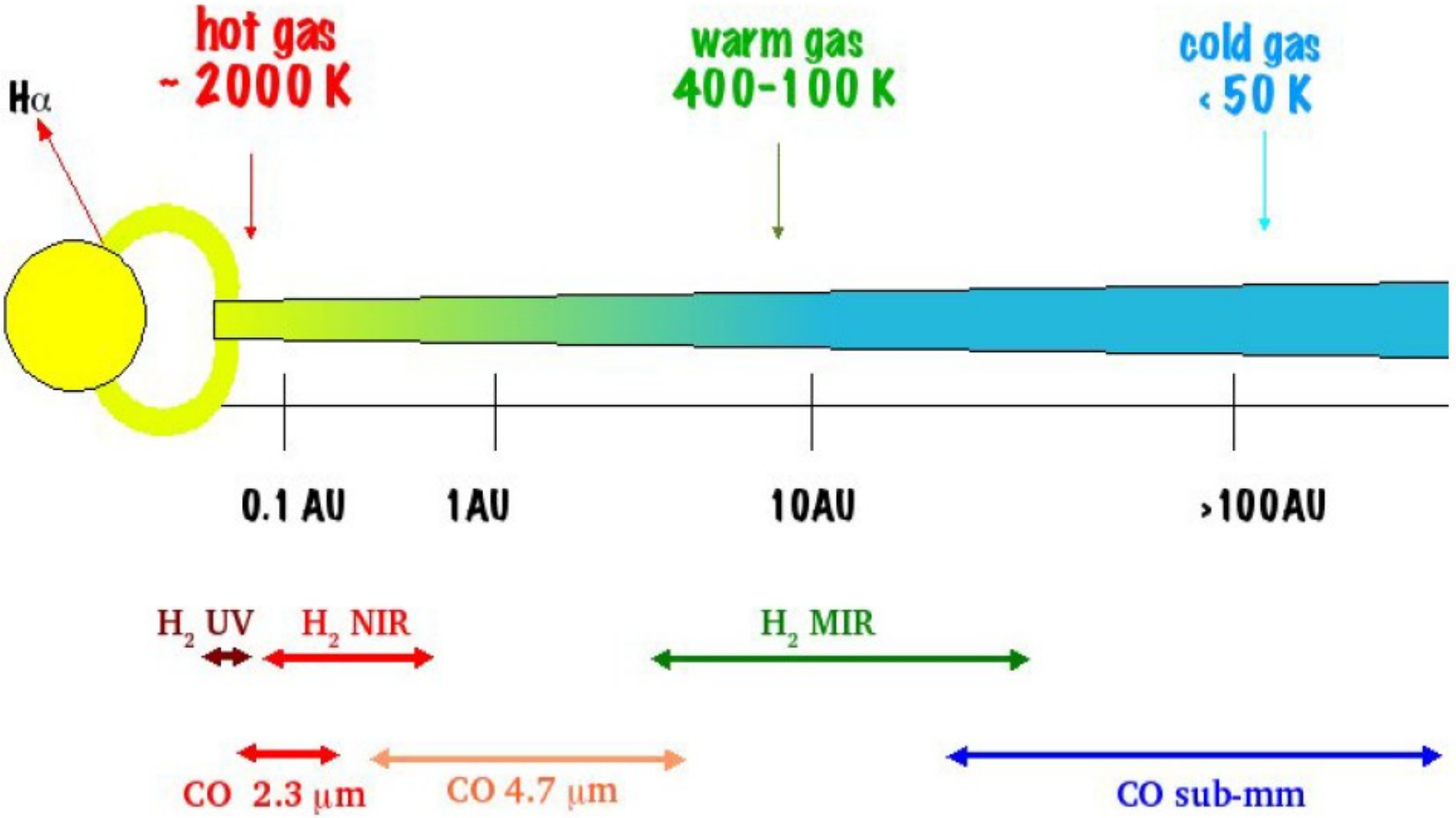
MAD
Millenium ALMA Disk Nucleus

ESO

CONICYT
Ministerio de Educación
Gobierno de Chile

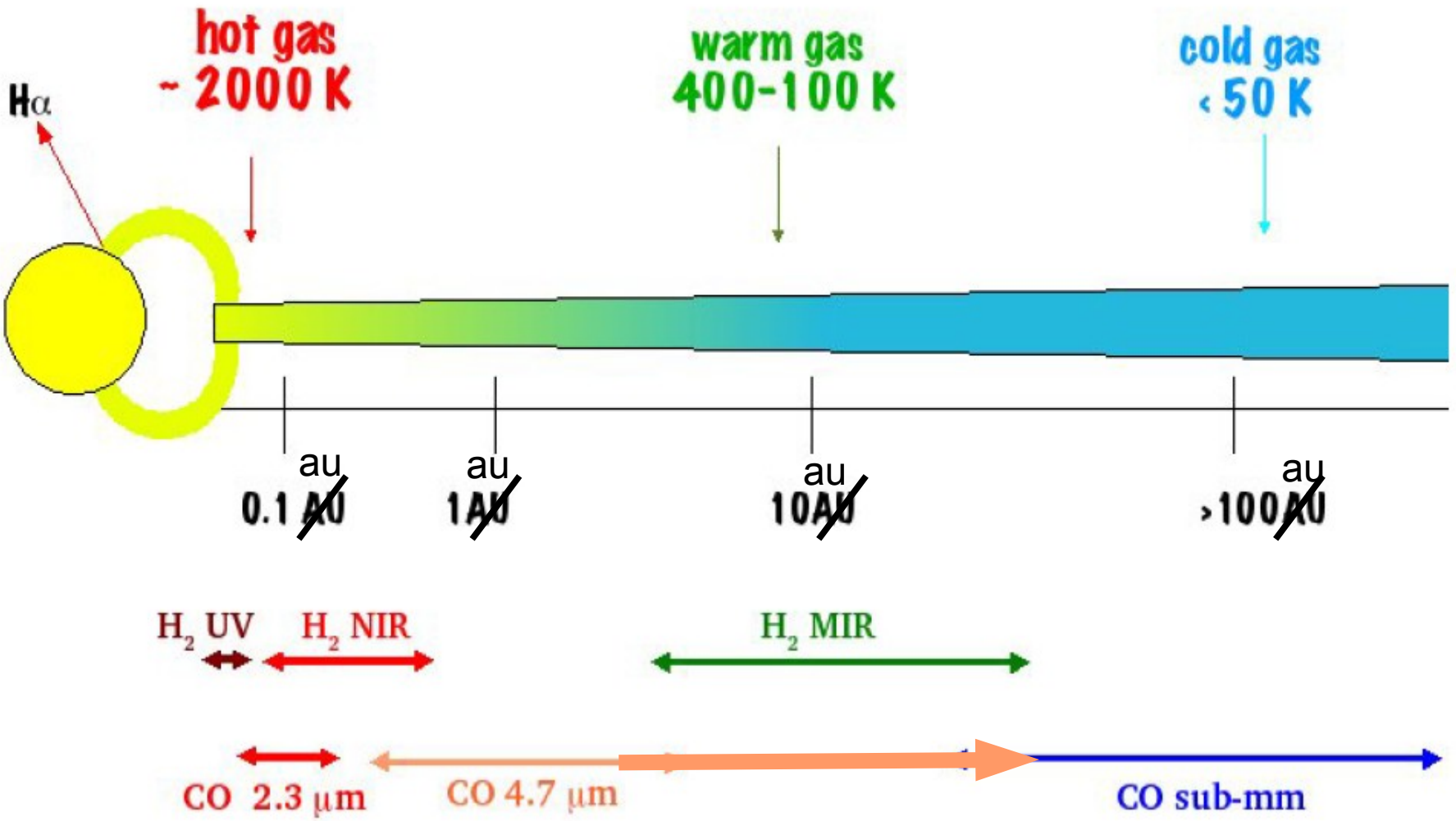
FONDECYT
Fondo Nacional de Desarrollo Científico y Tecnológico

What can CO do for you?



Carmona et al. 2010

What can CO do for you?



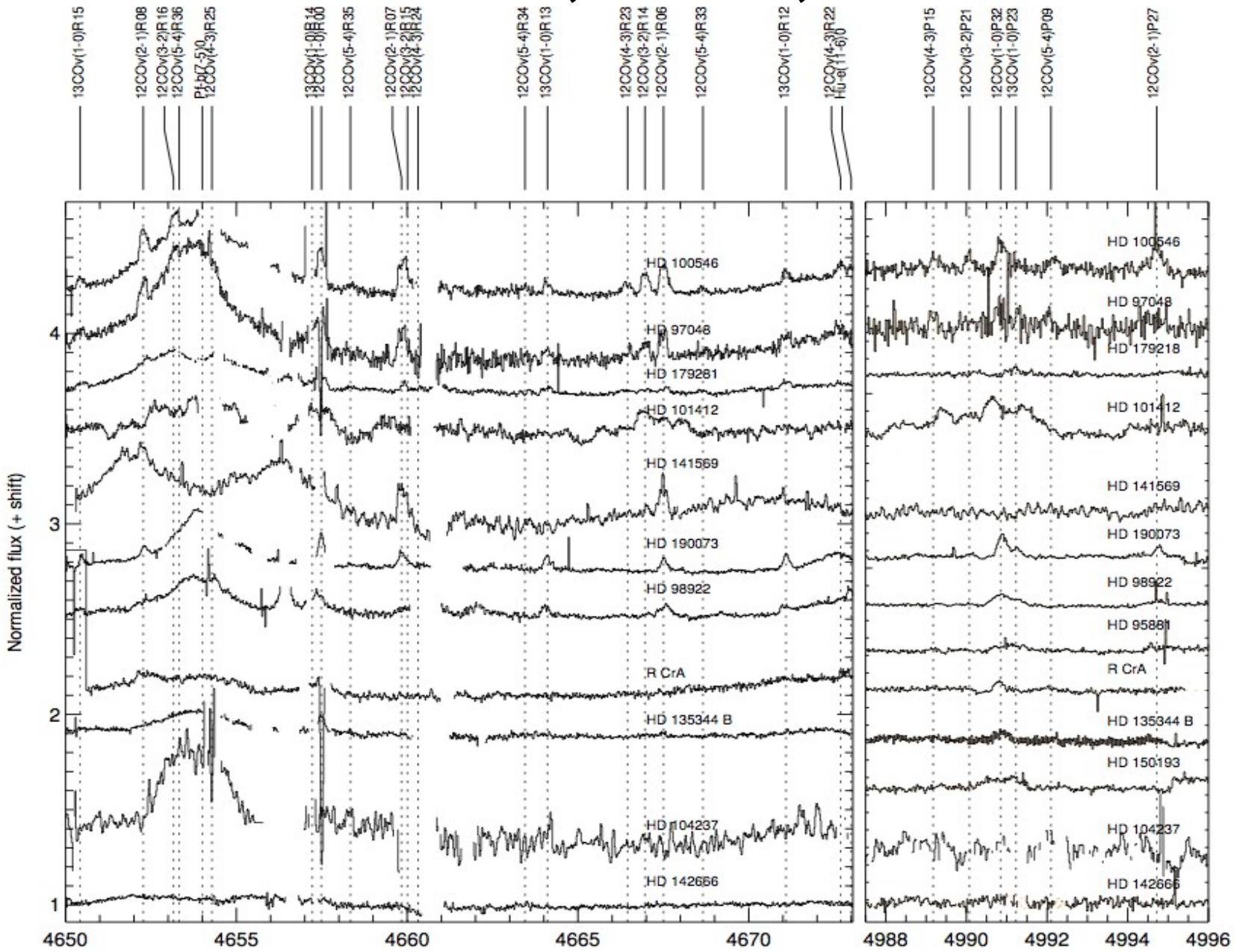
Carmona et al. 2010

(incomplete) Past results

- Mitchell et al. 1990; Najita et al. 2003; Blake & Boogert 2004; **Brittain** et al. 2005, 7 ,9 ,13; Pontoppidan et al 2003, 8,11; Goto et al 2006,12; Salyk et al 2007, 9, 11; **van der Plas** et al. 2009, this work; Bast et al 2011; Brown et al. 2013; **Thi** et al. 2013; **Bertelsen** et al. 2013

- Applications: Temperature (also as function of radius!), CO gas in gaps (kinematics + spectro-astrometry), non LTE excitation mechanisms, slow disk wind, group I/II

Lines, lines, lines....



HD 100546

HD 97048

HD 179281

HD 101412

HD 141569

HD 190073

HD 98922

HD 95881

R CrA

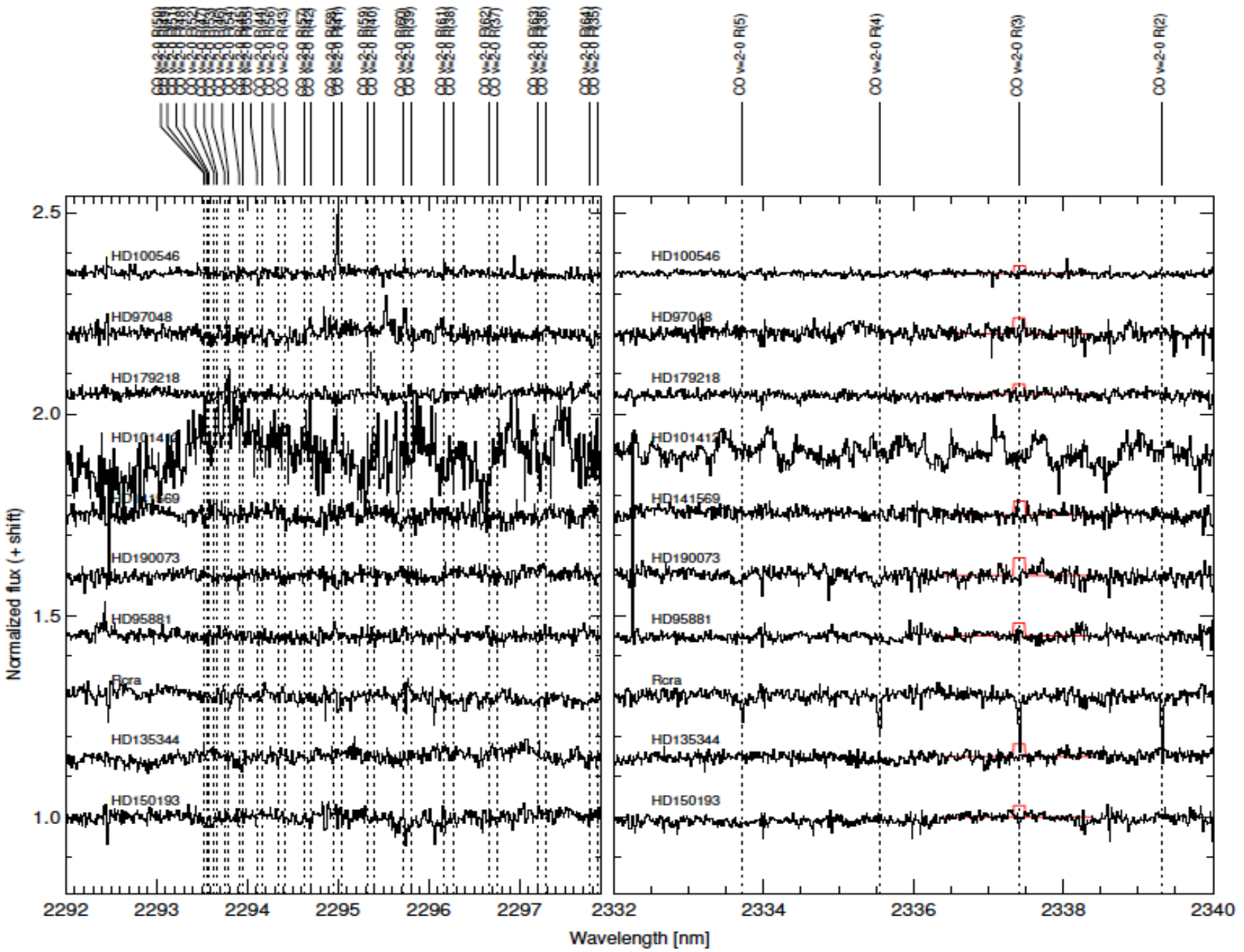
HD 135344B

HD 150193

HD 104237

HD 142666

Lines, lines, lines....



HD 100546

HD 97048

HD 179281

HD 101412

HD 141569

HD 190073

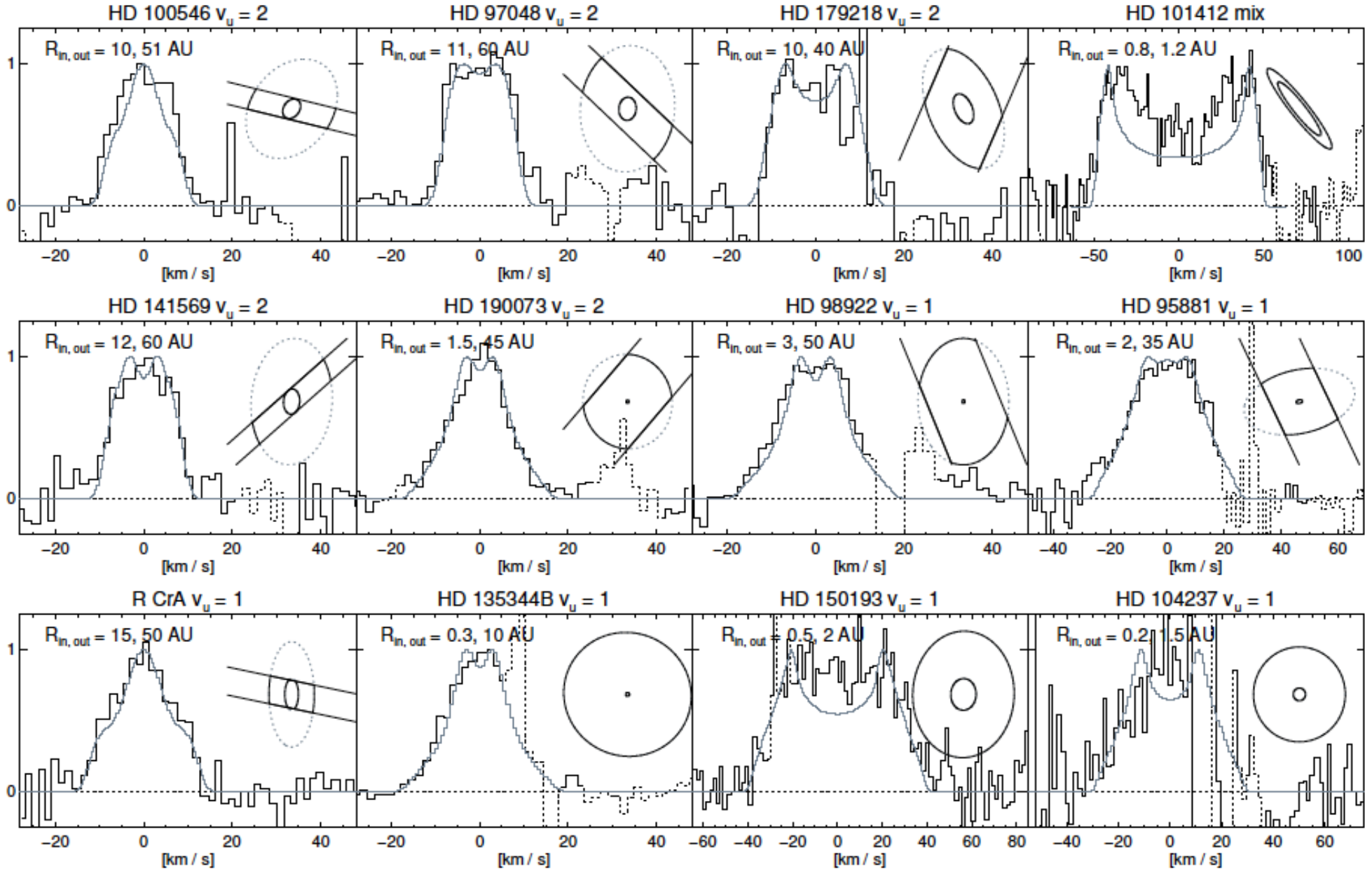
HD 95881

R CrA

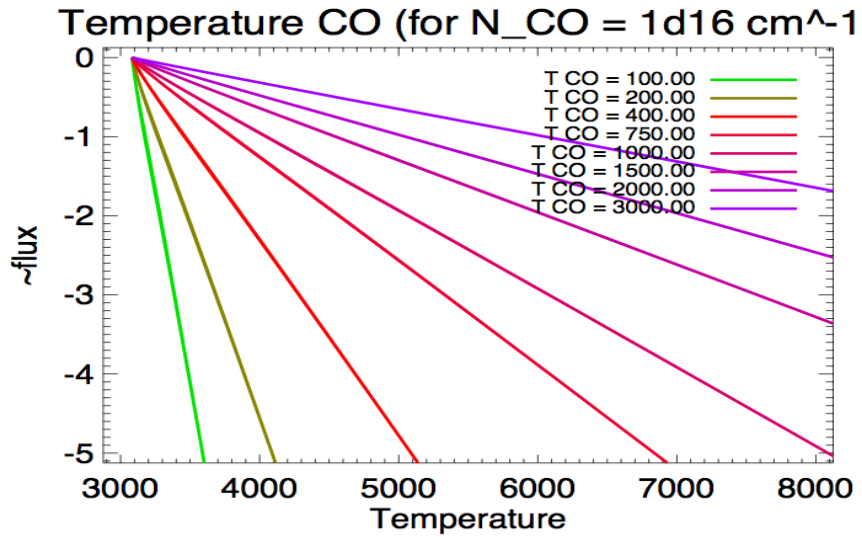
HD 135344B

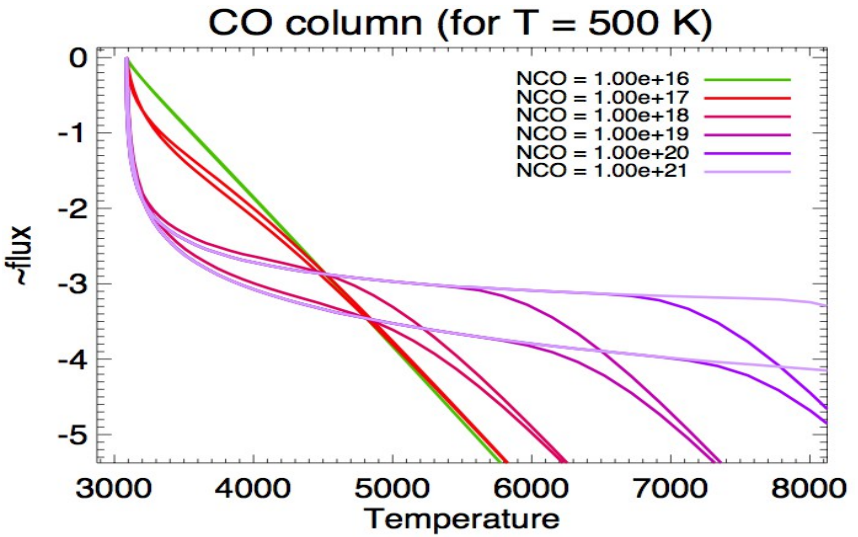
HD 150193

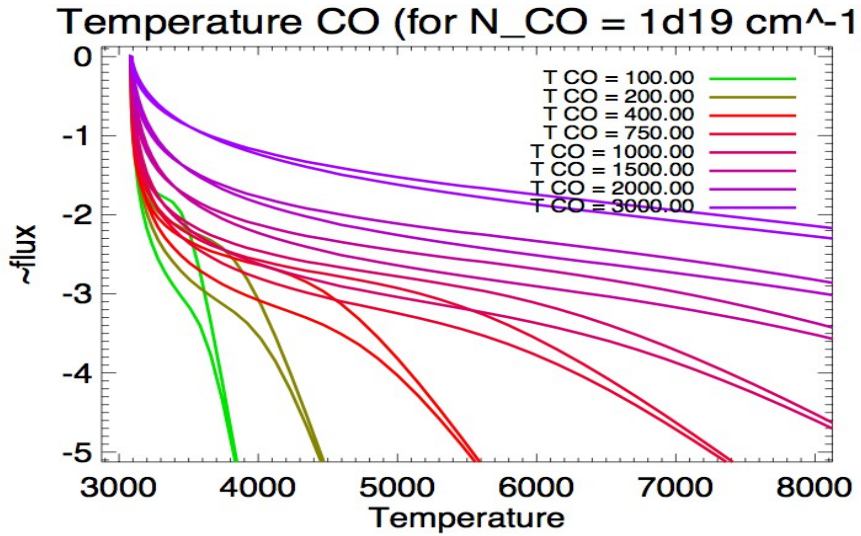
Disks, disks, …….disks?

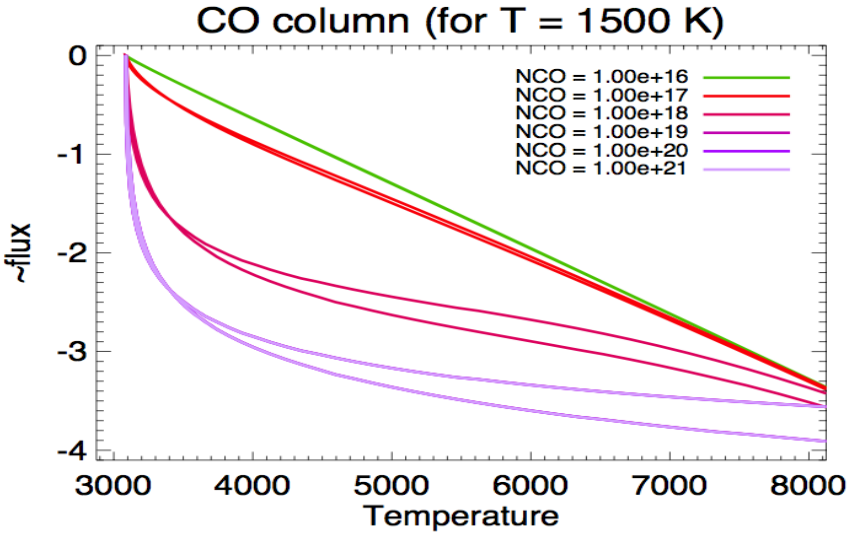


Rotational diagrams

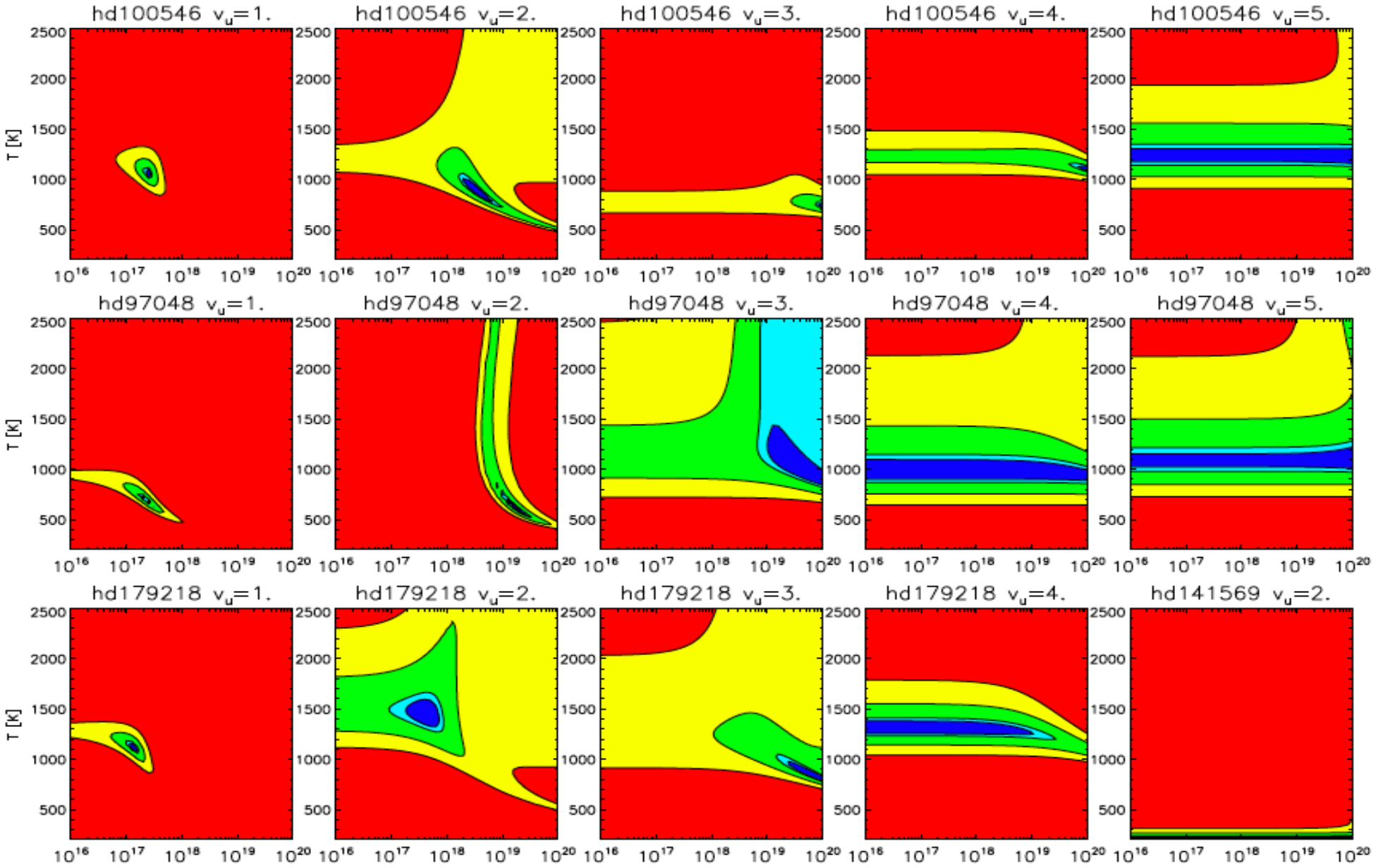




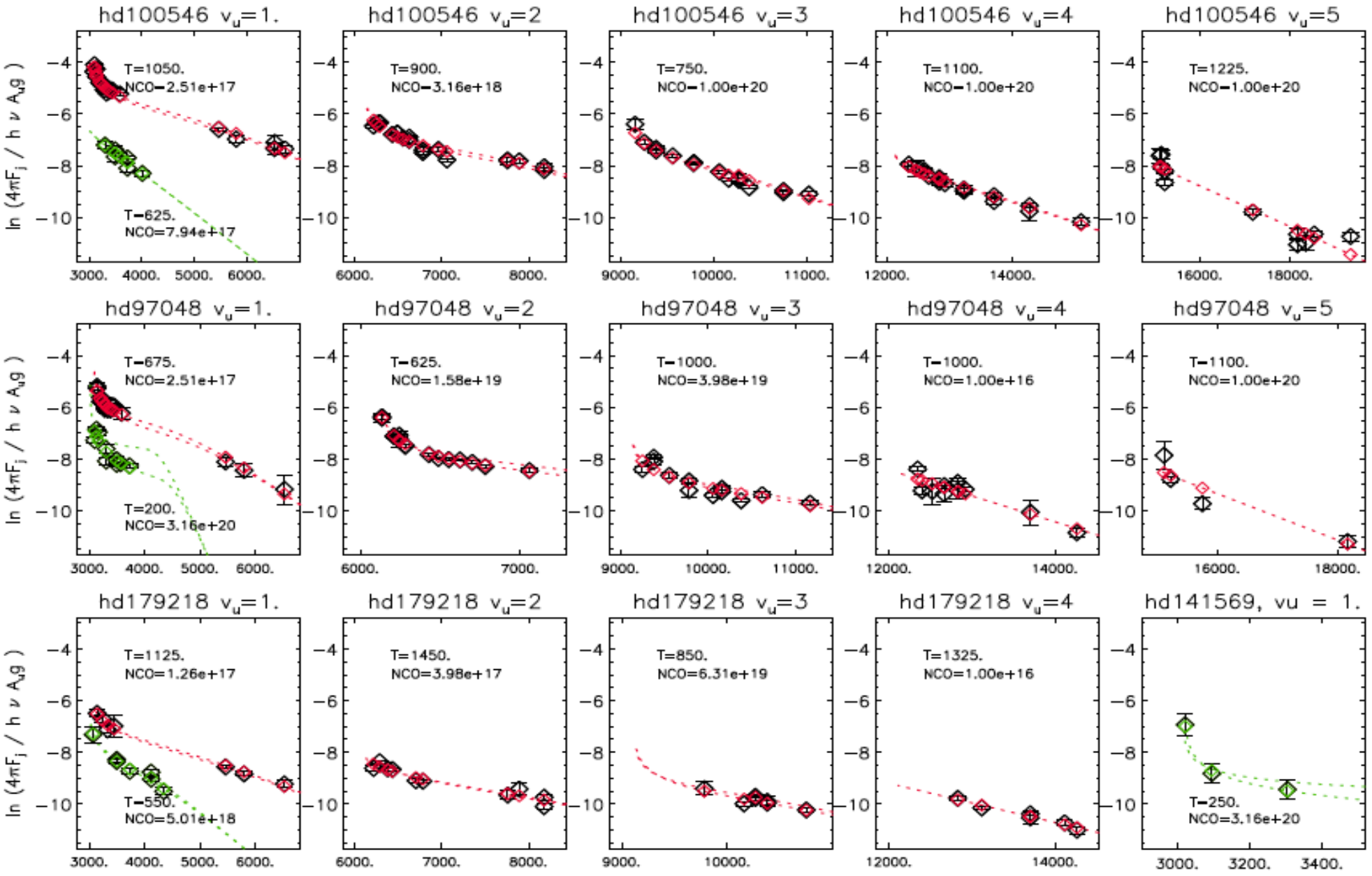




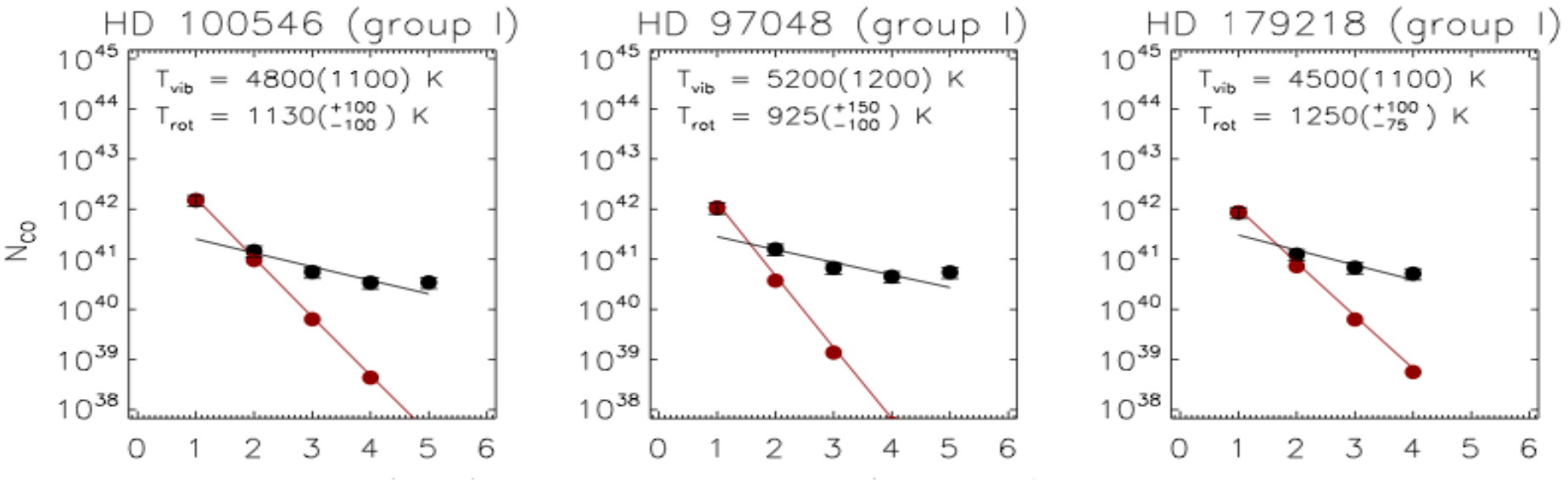
CO emission in Group I disks



CO emission in Group I disks



CO Excitation mechanism?

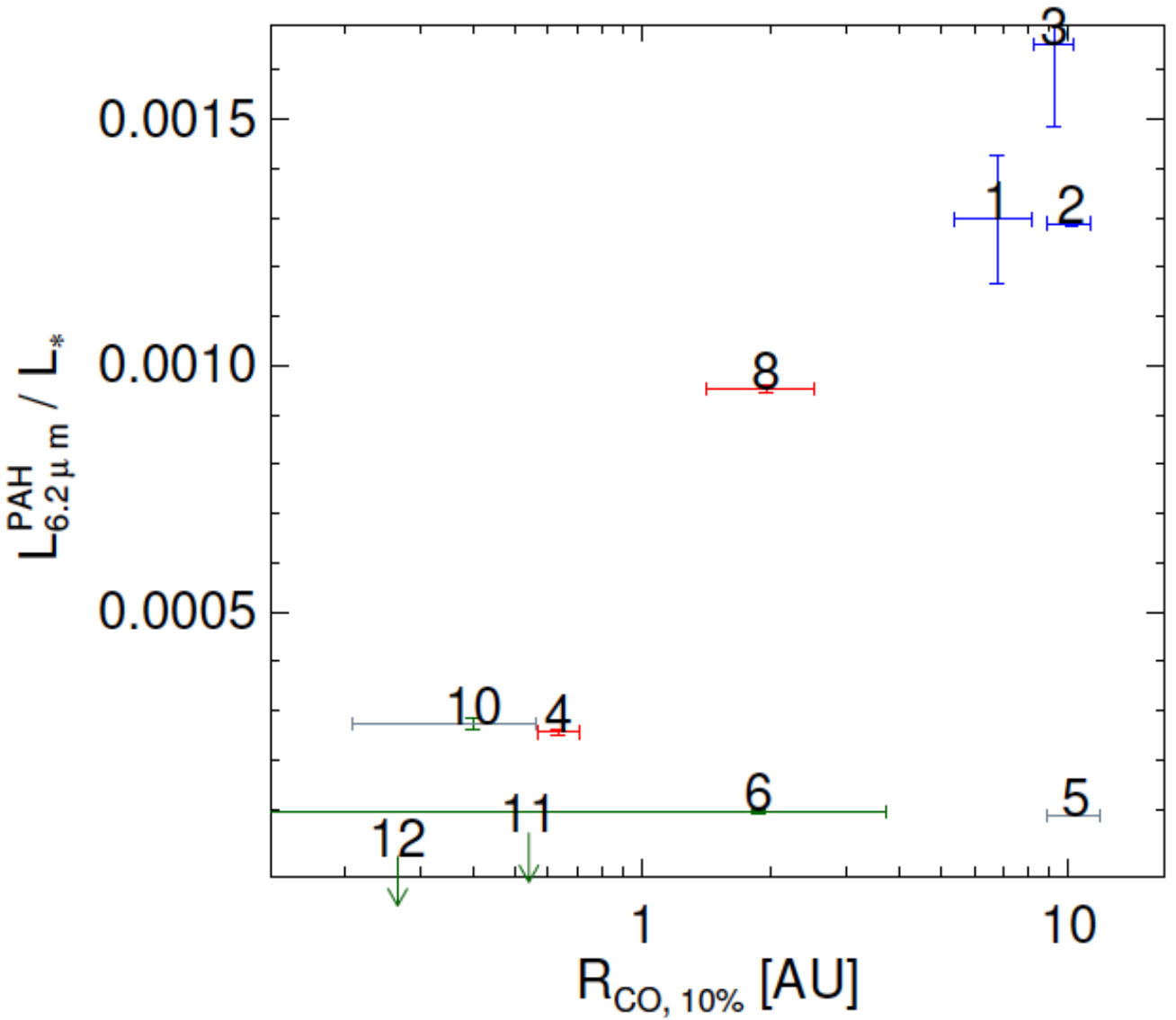


Group I vs Group II

- Line profiles: narrow, with a typical *inner* radius of ~10 AU
- Excitation mechanism: UV fluorescence
- Spatial extent? Resolved up to 10s of AU
- How typical are these 3 disks for group I? (see e.g. AB Aur?)

- Line profiles: wide(r), up to ~ dust sublimation radius.
- Excitation mechanism: collisional excitation
- Spatial extent? No (<~5 AU)

Group I / II



Conclusions

- CO ro-vibrational emission is an extremely versatile tracer of the inner (tenths to tens of au) disk surface (and a few other places).
- In this Herbig Ae/Be sample CO emission from group I and II sources is distinctly different. Flaring or gaps?
- Other uses (and especially in combination with spectro-astrometry): help constrain the unifying disk model of your favorite HAeBe (c.f. talk C. Pinte // A. Carmona)