CO line SEDs in local (U)LIRGs with APEX

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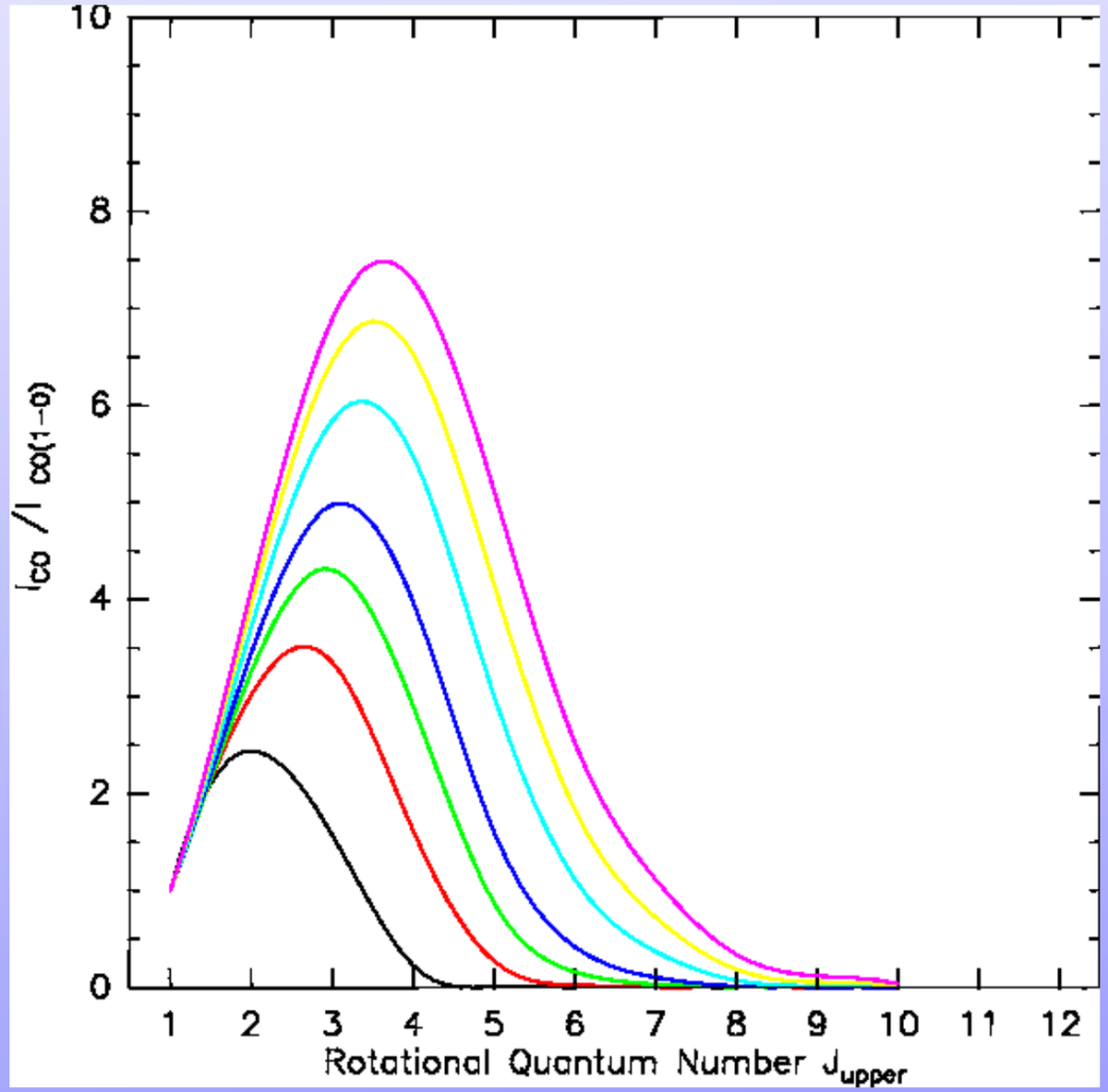
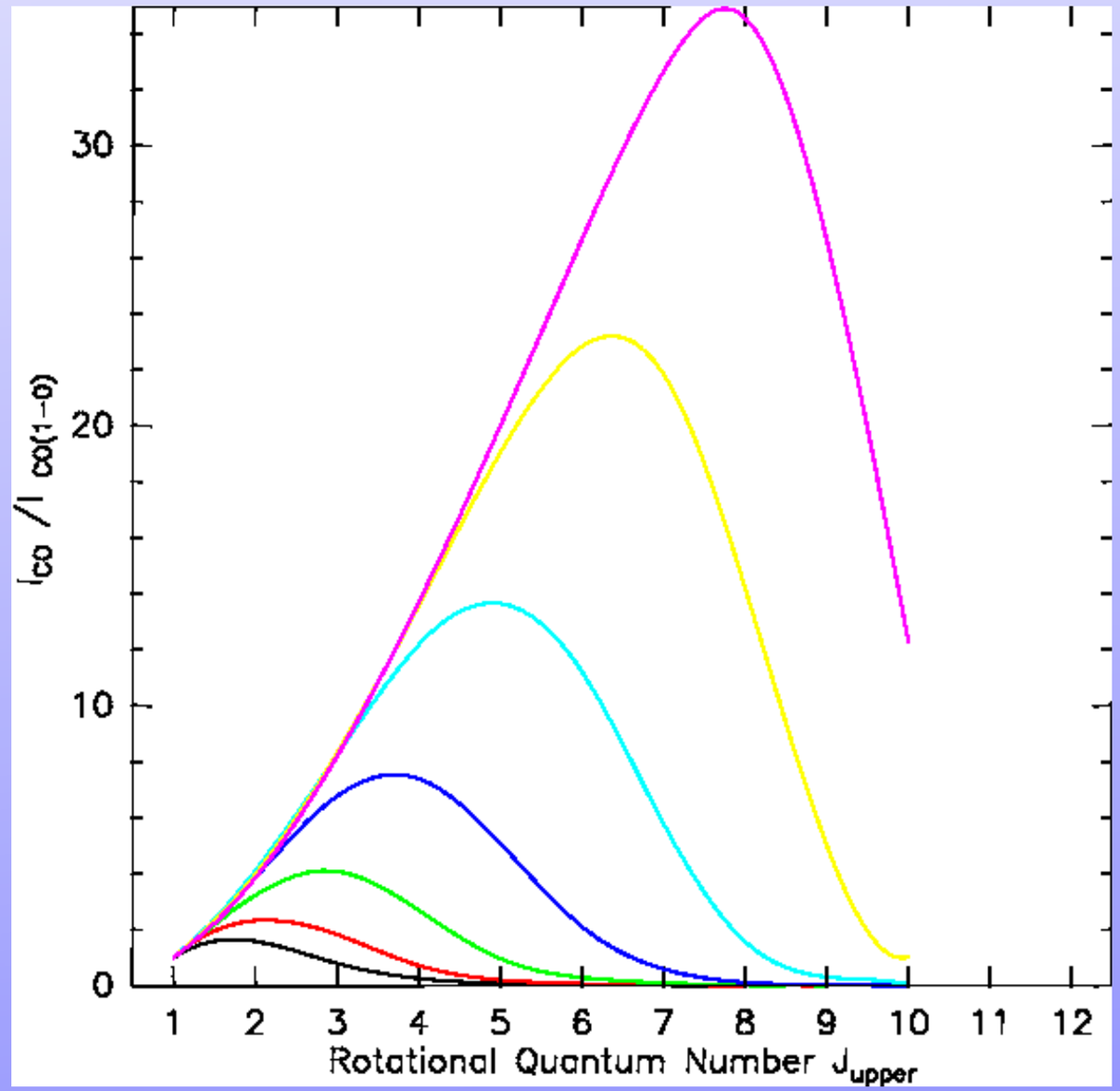
Gas Excitation from CO line SEDs

$n=10^{3.0}$ cm^{-3}, T=10,20,30,40...100 K



T=50 K, log n=2.0,2.4,2.8...4.4



CO line SEDs for local (U)LIRGs

- **A sample of nearby (U)LIRGs carried out with APEX (2006.06 to 2009.08)**

  ^{12}CO 3-2 4-3 6-5 7-6 maps were obtained for most sources

  source list:

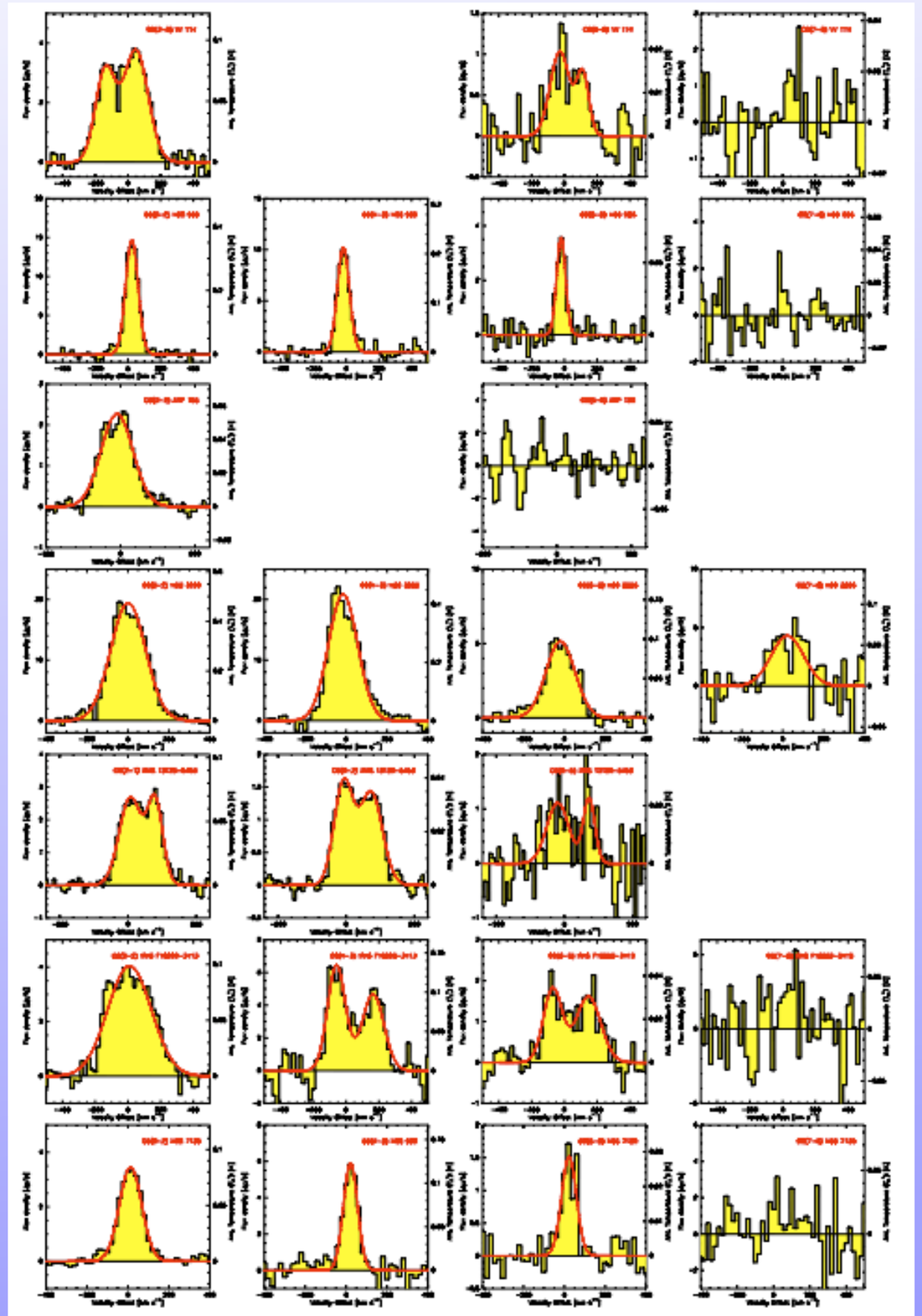
  NGC 986, NGC 7130, VV114, NGC3256, ARP 186, IRAS 13120-5453,

  IRAS F18293-3413

- **^{13}CO J=1-0 and 2-1 data were available for some sources in literatures**

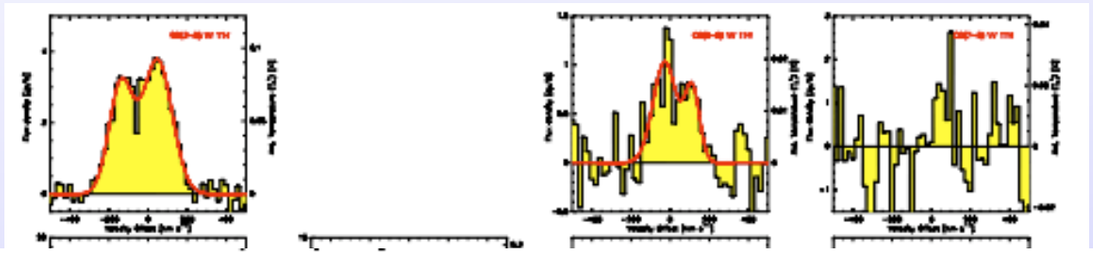
Results

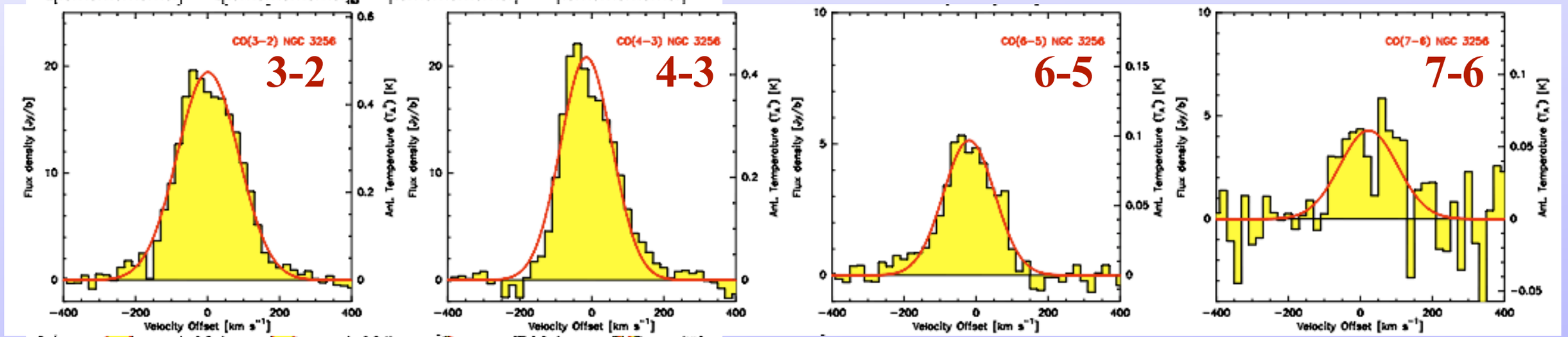
3-2 4-3 6-5 7-6

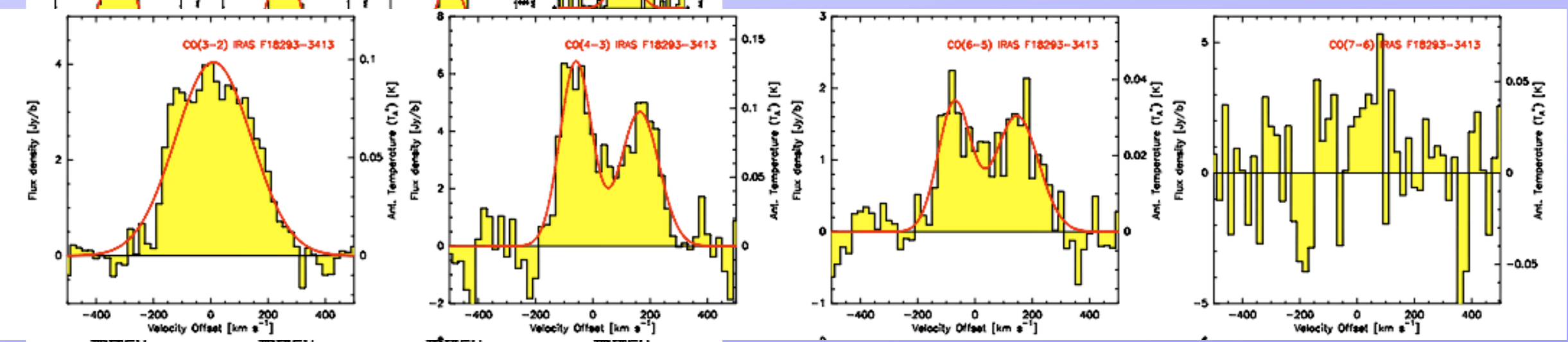


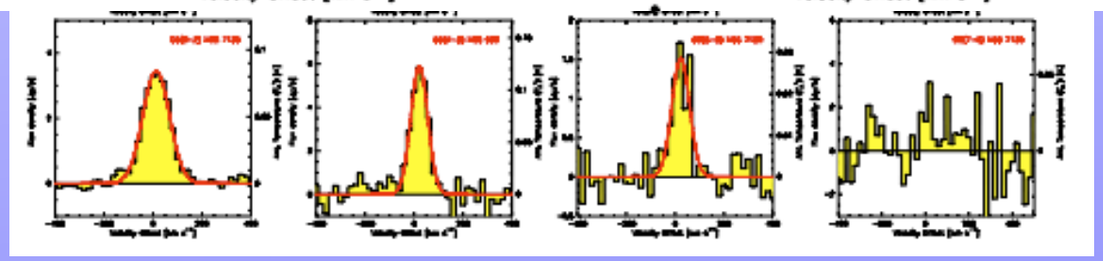
Results

3-2 **4-3** **6-5** **7-6**

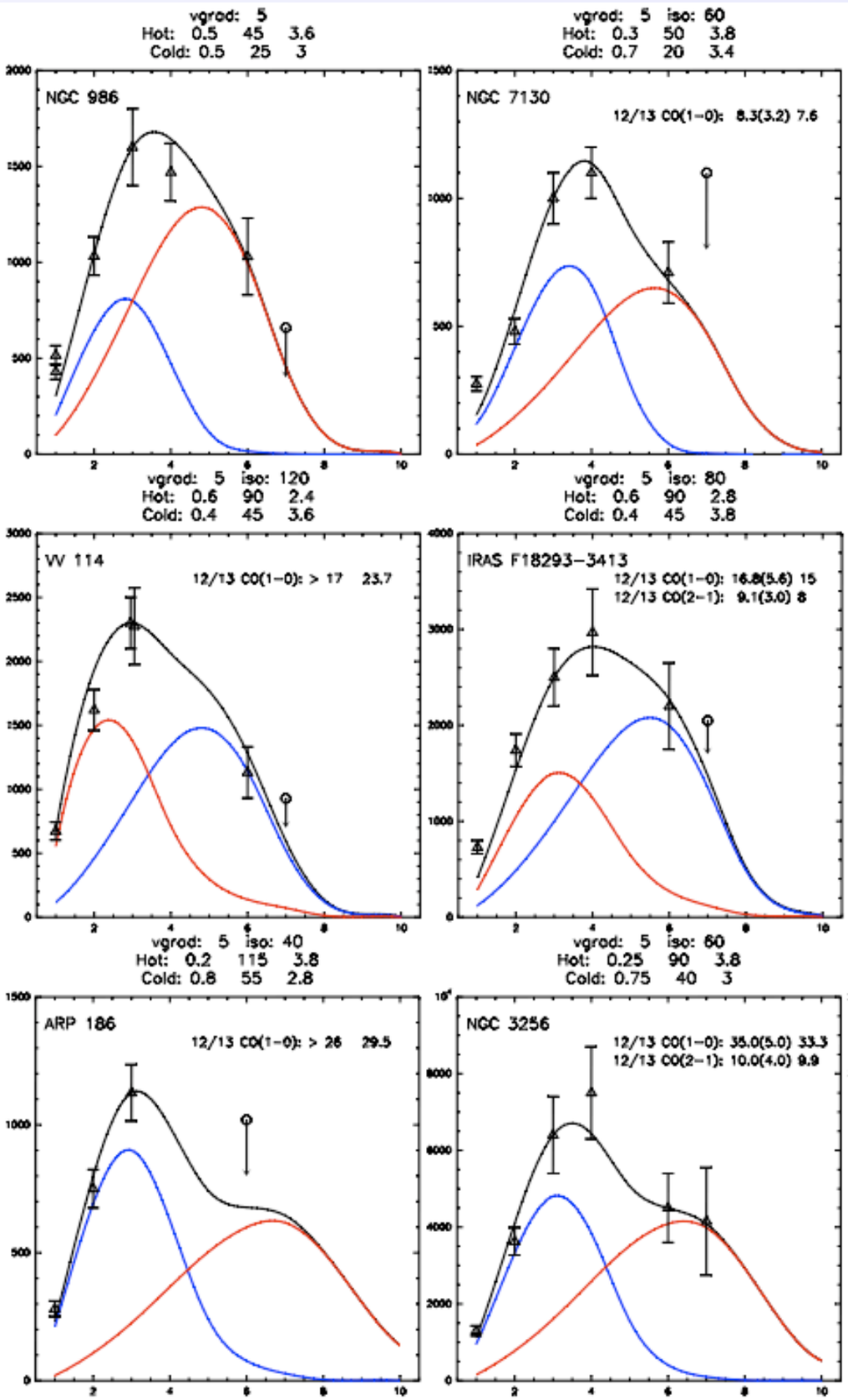






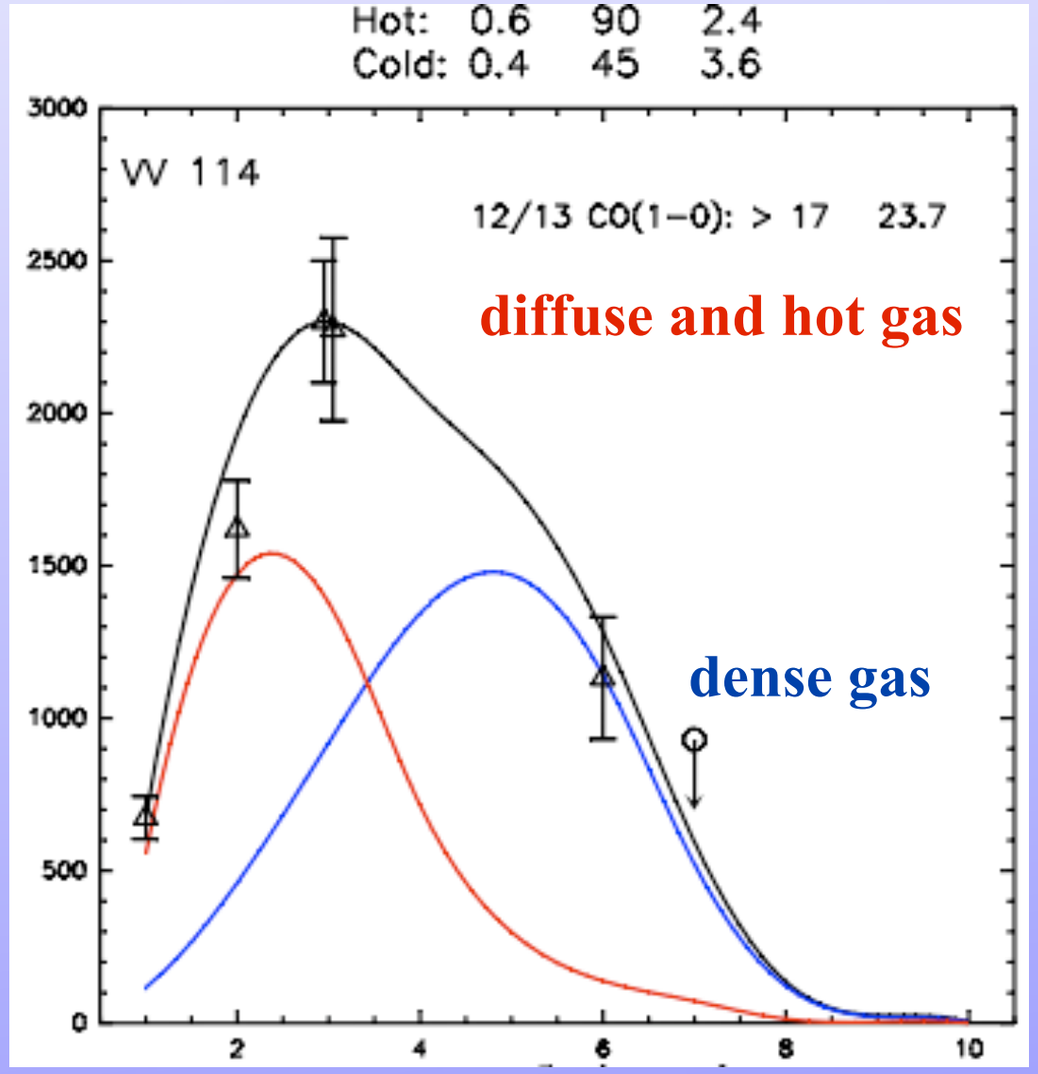


CO line SEDs

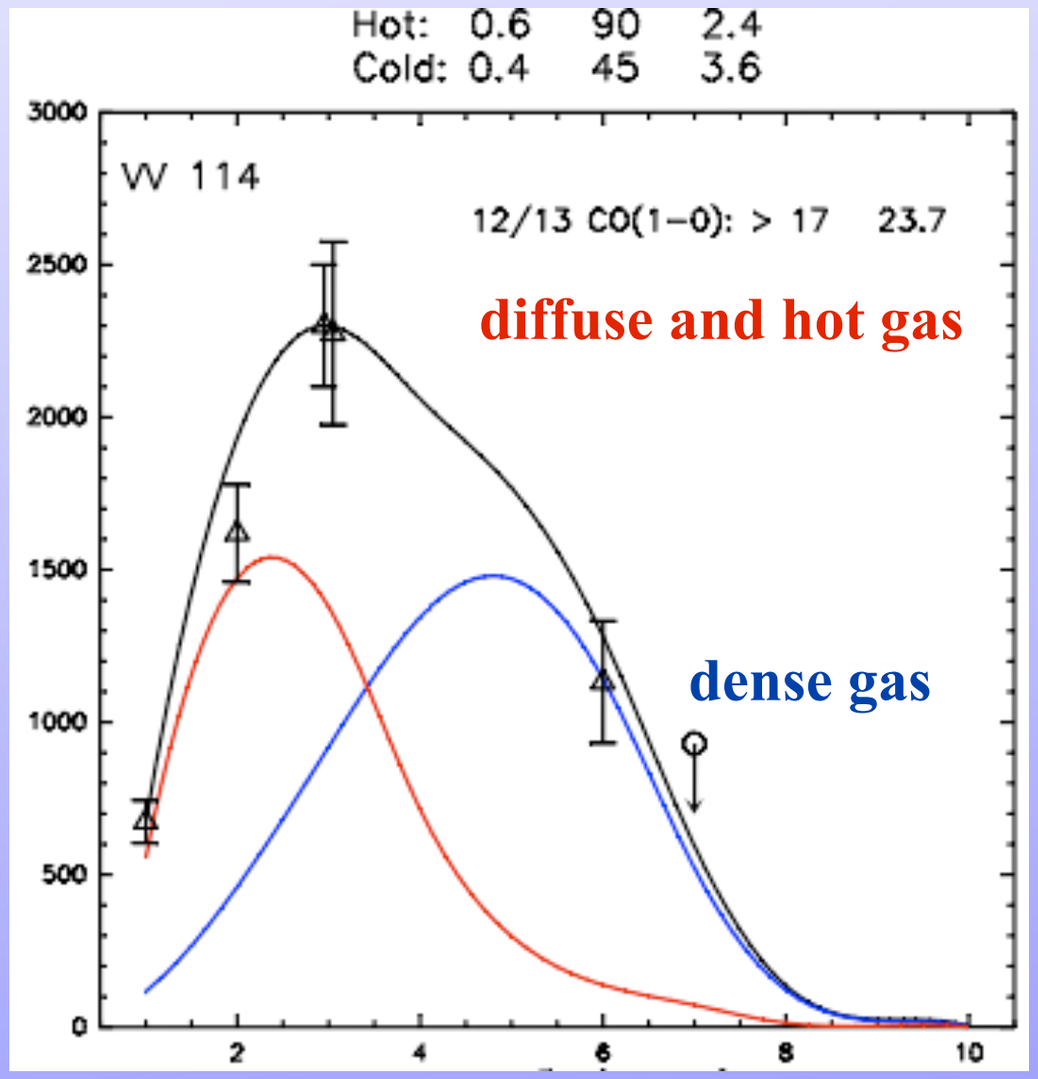


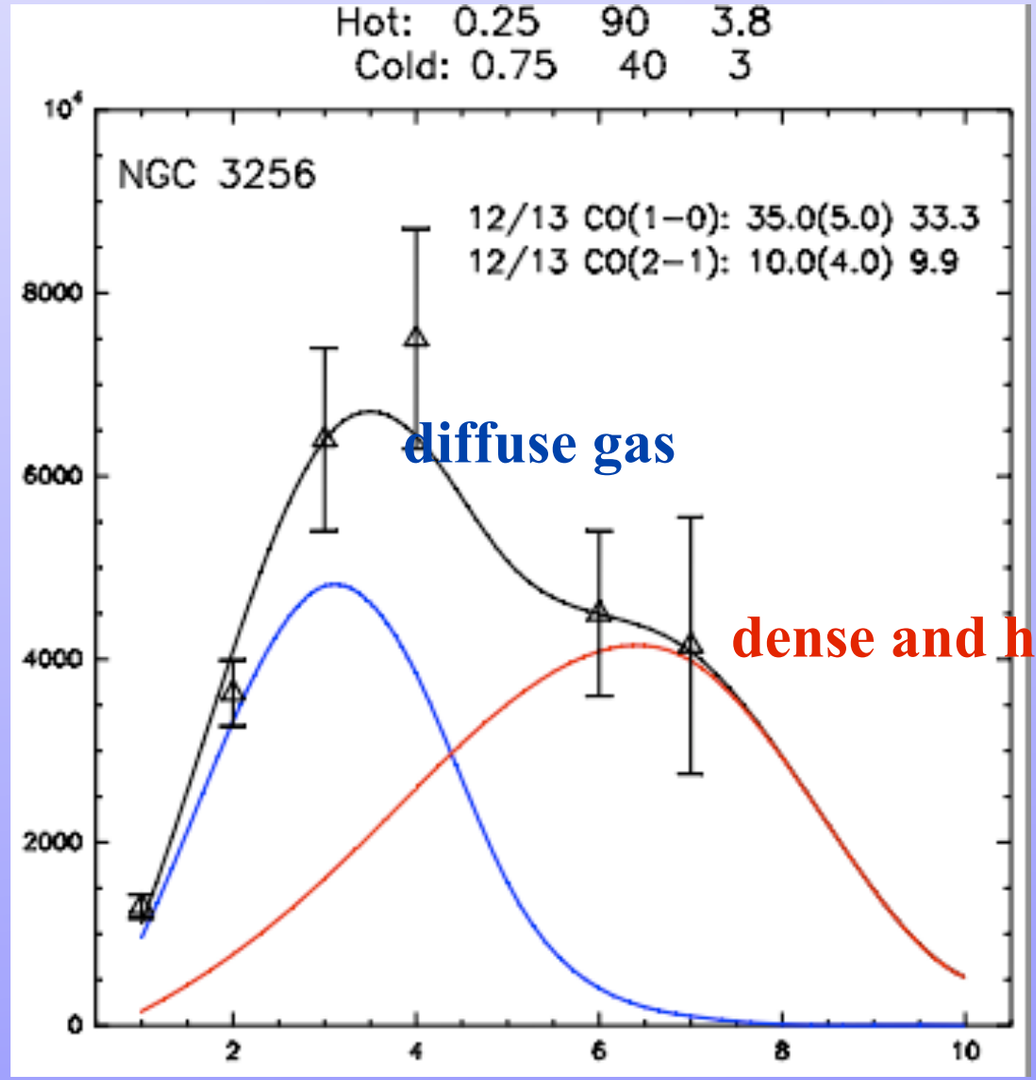
- ***SEDs turn over at around 4-3***
- ***all sources have two gas components: low excited and high excited ones***

Two component models

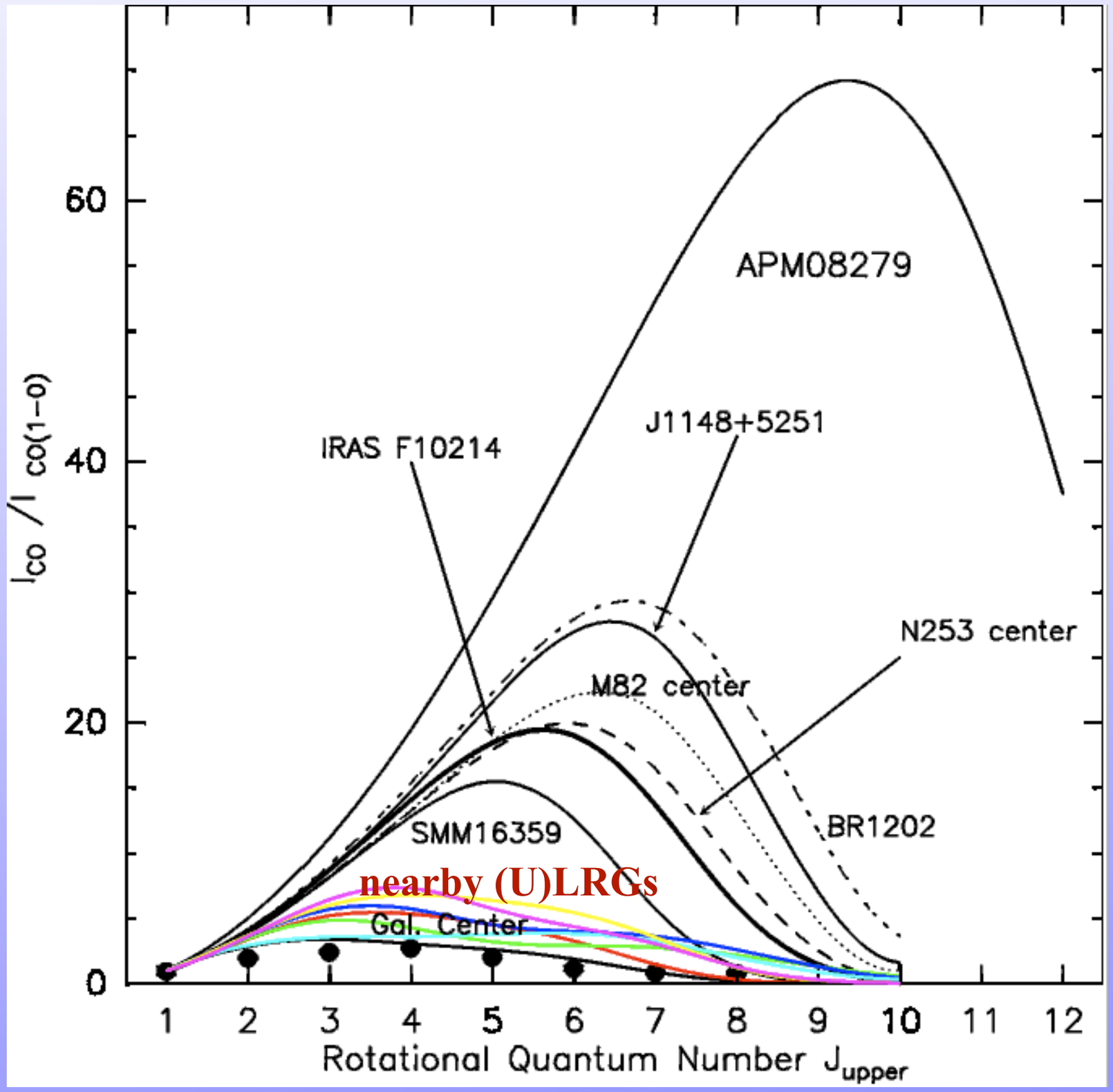


Two component models



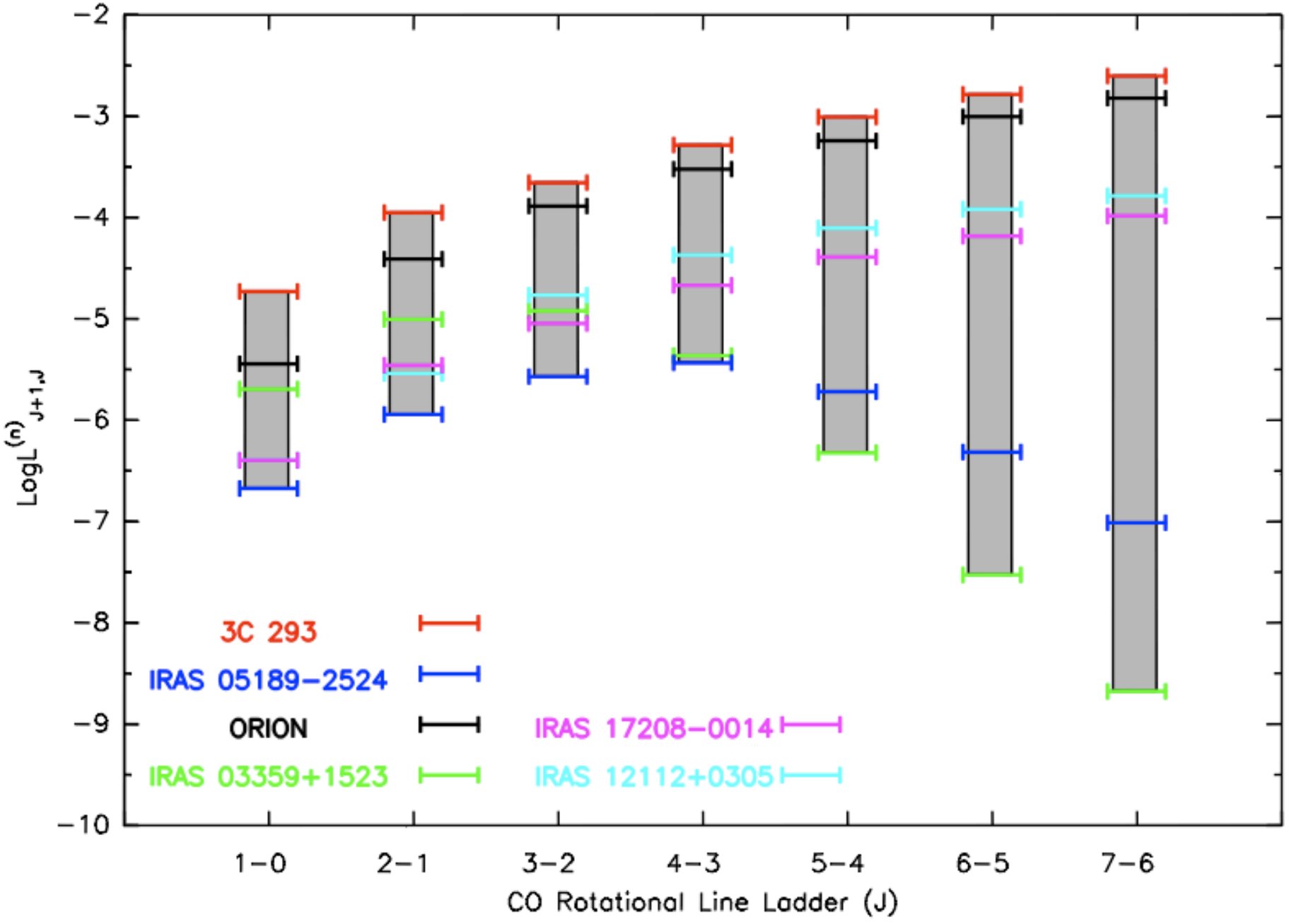


Compare with other types of sources



- ***SMM sources turn over at 5-4***
- ***QSOs and starburst centers turn over at around 6-5 or higher***

Some extreme CO line SEDs



- **"Hot" CO SED**

Cosmic-ray heating or Turbulence heating?

- **"Cold" CO SED**

high dust optical depth at submm wavelength

e.g., ARP 220

Papadopoulos et al. 2010

Fischer et al. 2012 in preparation

Papadopoulos et al. 2012 MNRAS in press

Thanks!