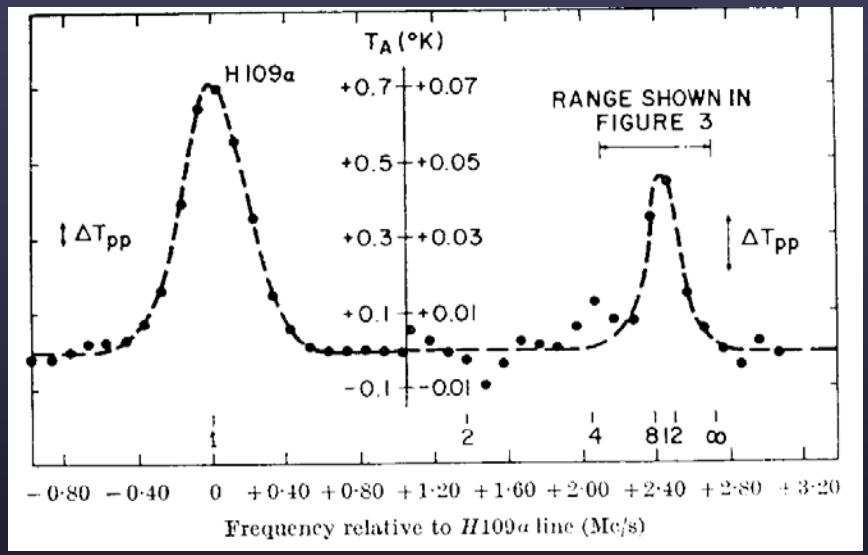
Carbon RRLs towards Ultra-compact HII Regions
Dana S. Balser

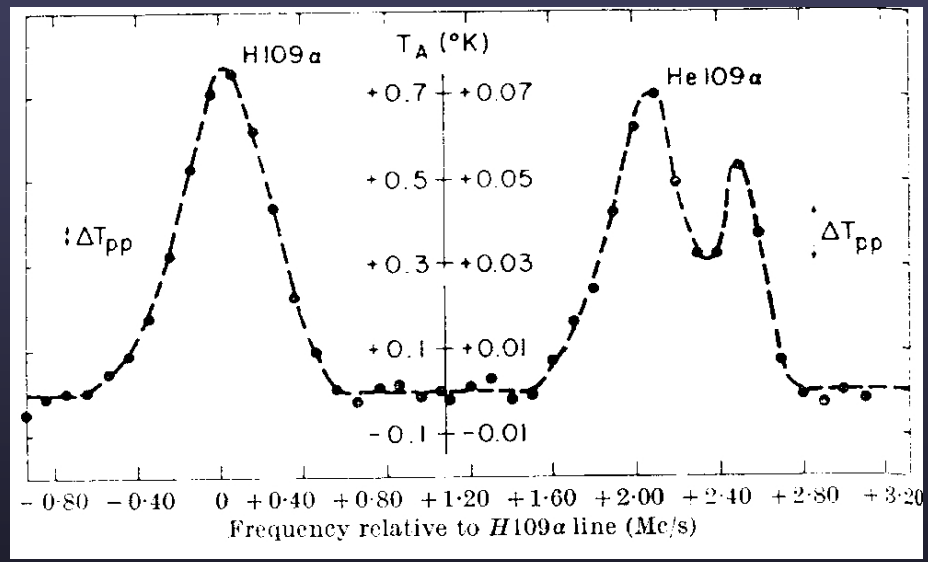
D. Anish Roshi (Raman Research Institute)
T.M. Bania (Institute for Astrophysical Research)
W. M. Goss (NRAO)
C. G. De Pree (Agnes Scott College)

Carbon Radio Recombination Lines (RRLs)

NGC 2024 (Orion B)

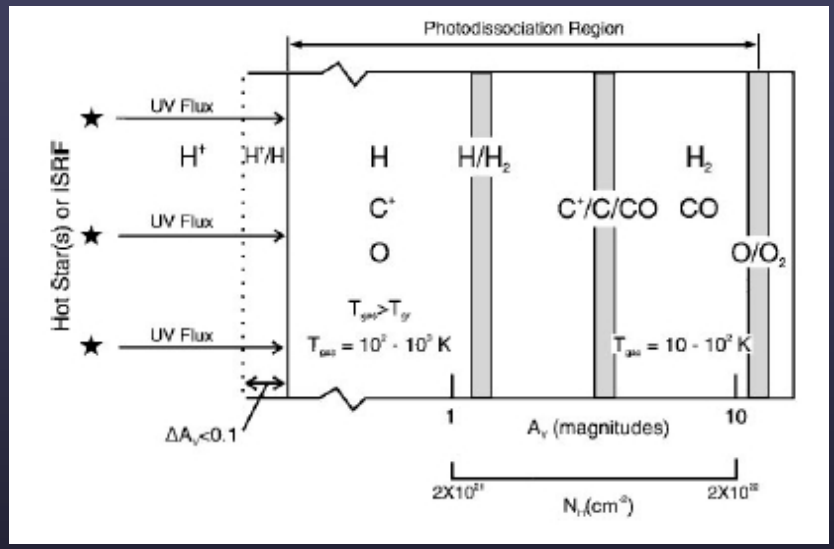


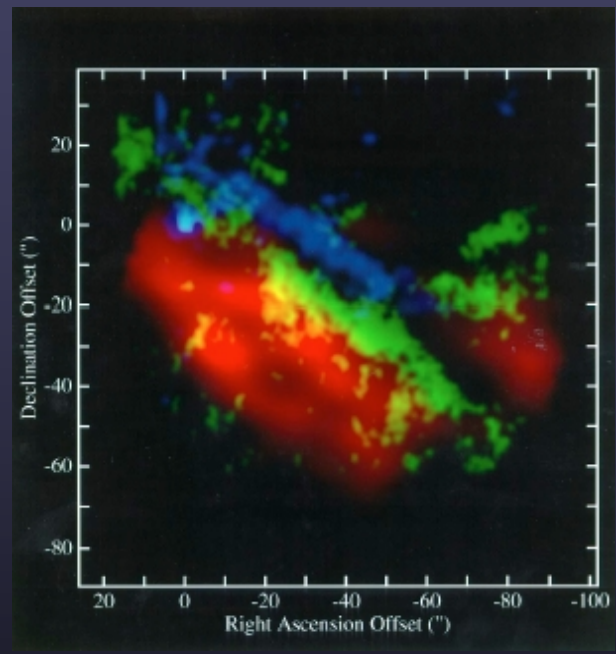
IC 1795 (W3)



Palmer et al. (1967)

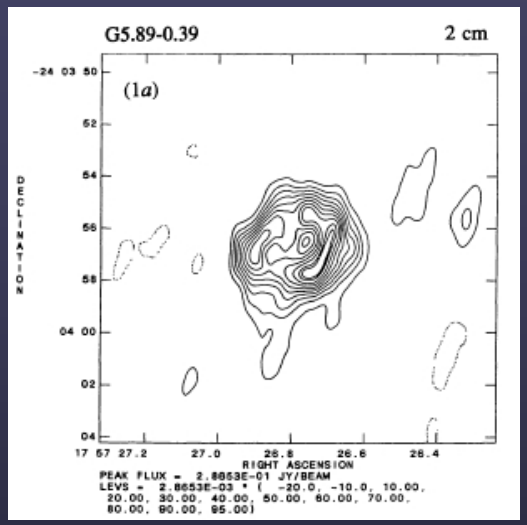
Photodissociation Regions (PDRs)

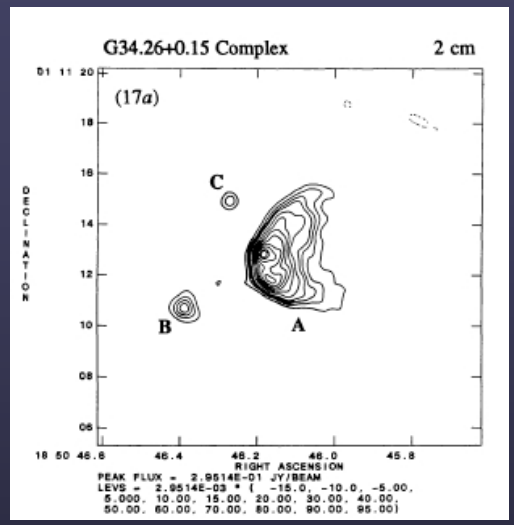


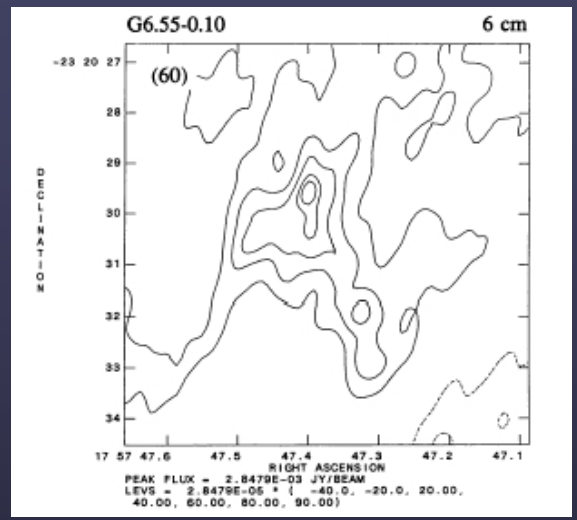


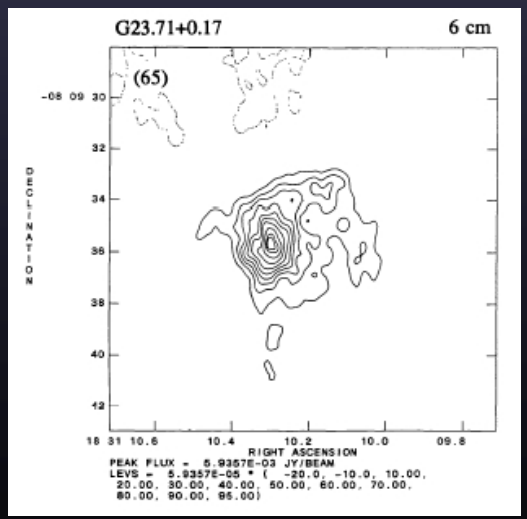
Hollenbach & Tielens (1997)

Ultra-Compact (UC) HII Regions









$$D \leq 0.1 pc$$

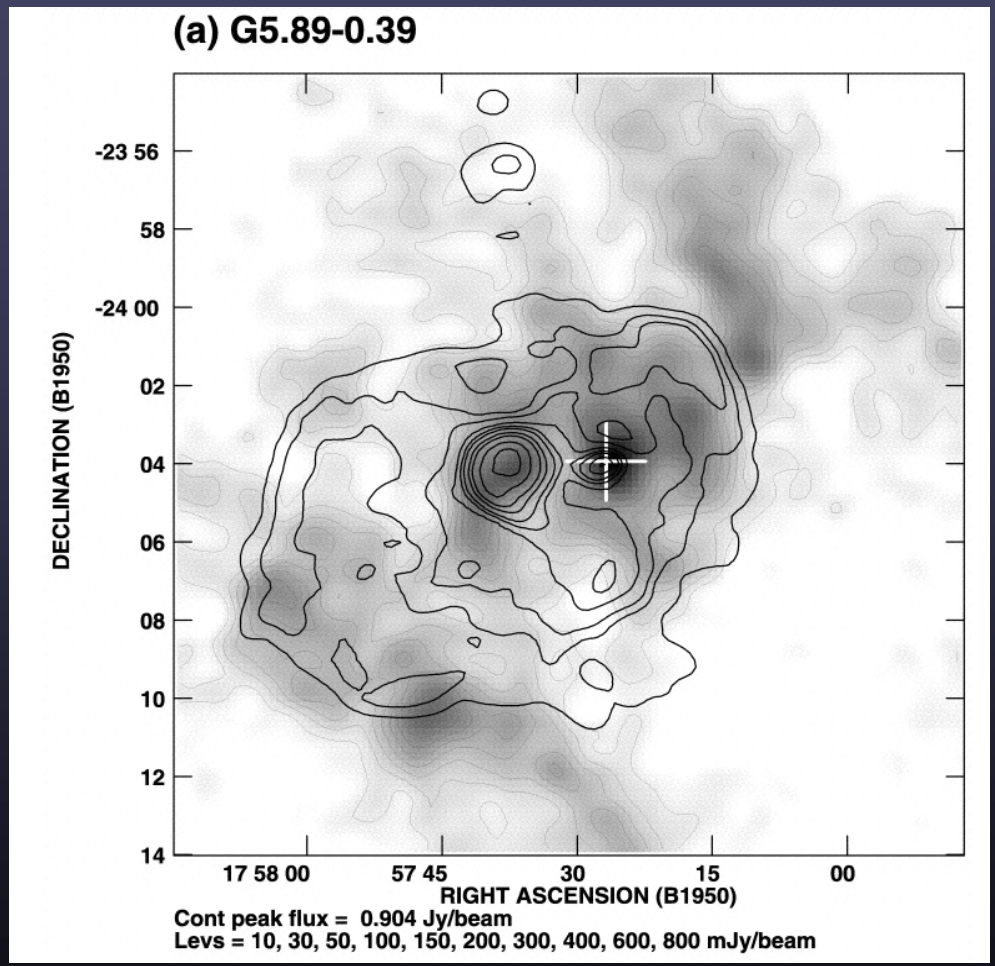
$$n_e \geq 10^4 cm^{-3}$$

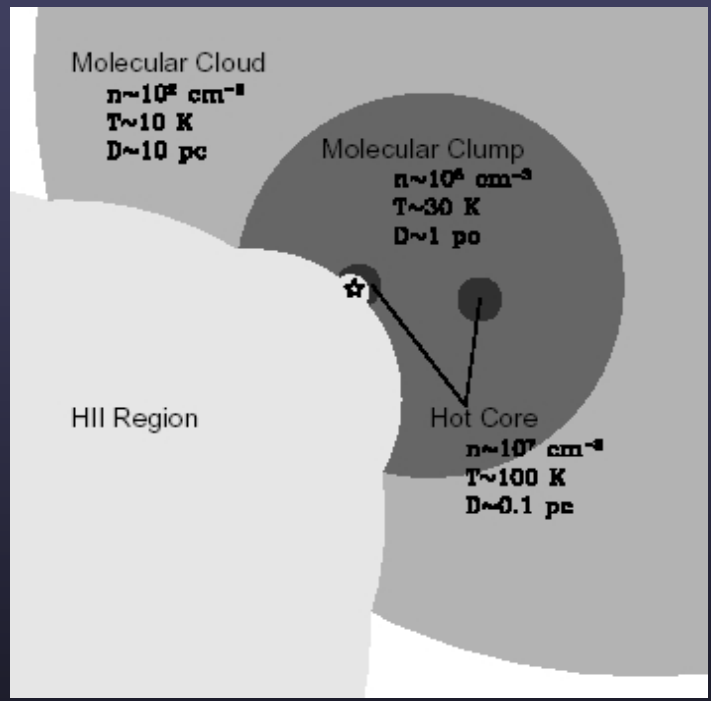
$$EM \geq 10^7 \, pc \, cm^{-6}$$

$$\tau \approx 10^5 \, yr$$

Wood & Churchwell (1989)

UC HII Regions: Morphology and Age





Kim & Koo (2001)
Kim & Koo (2003)

Survey of C RRLs towards UC HII Regions

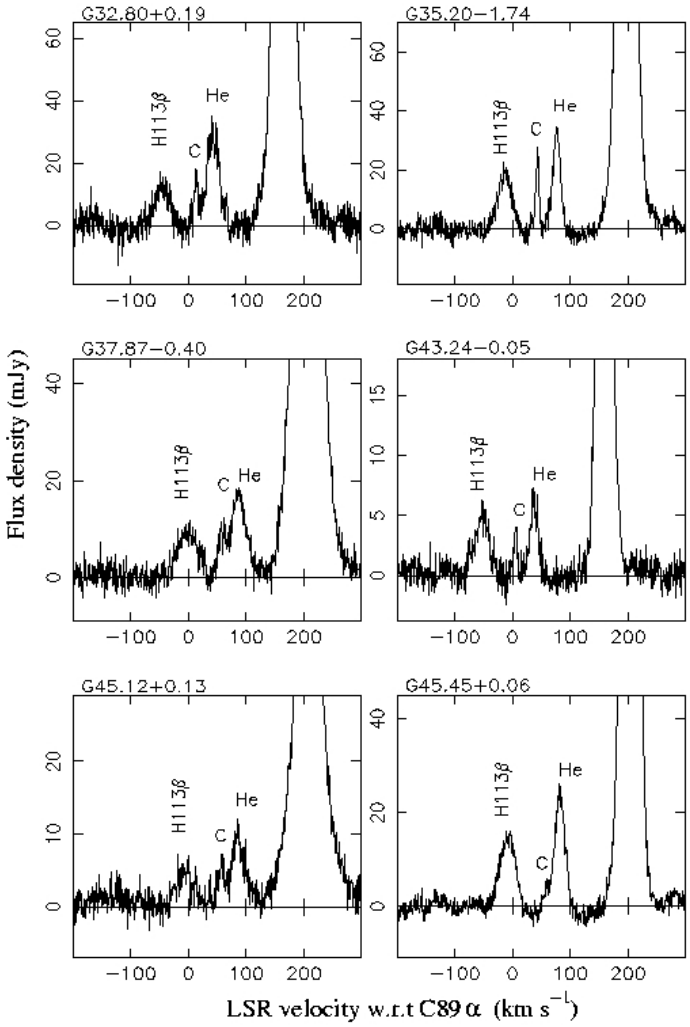
1. Observe 17 UC HII Regions near 8.5 GHz.
   (n=89, 90, 91, 92)

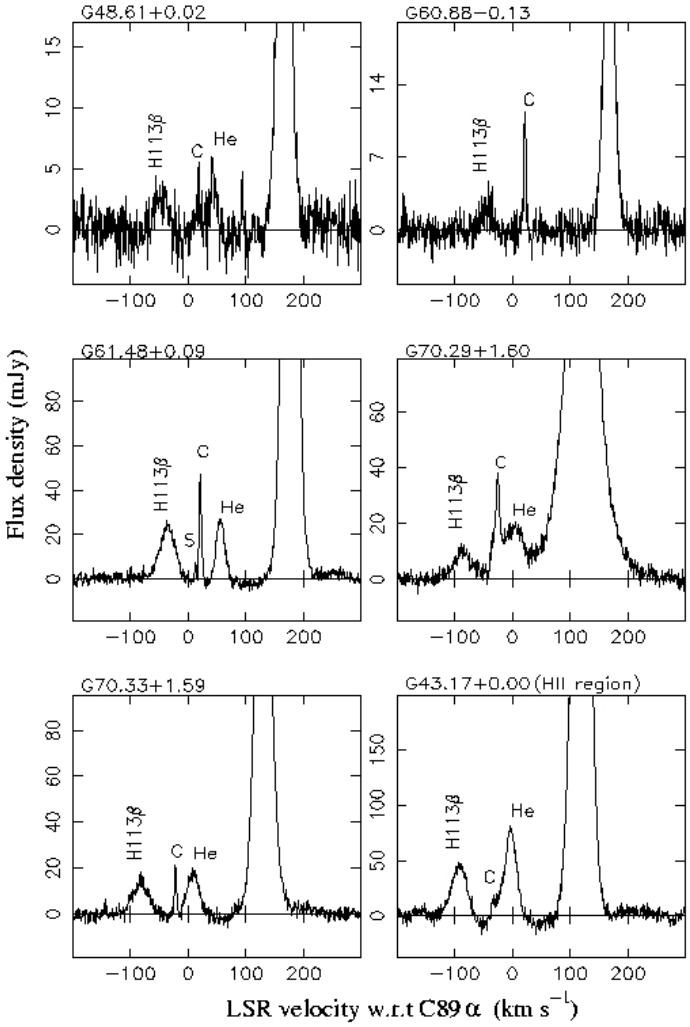
2. Observe all morphological types.

3. Flux density (2cm) > 150 mJy.

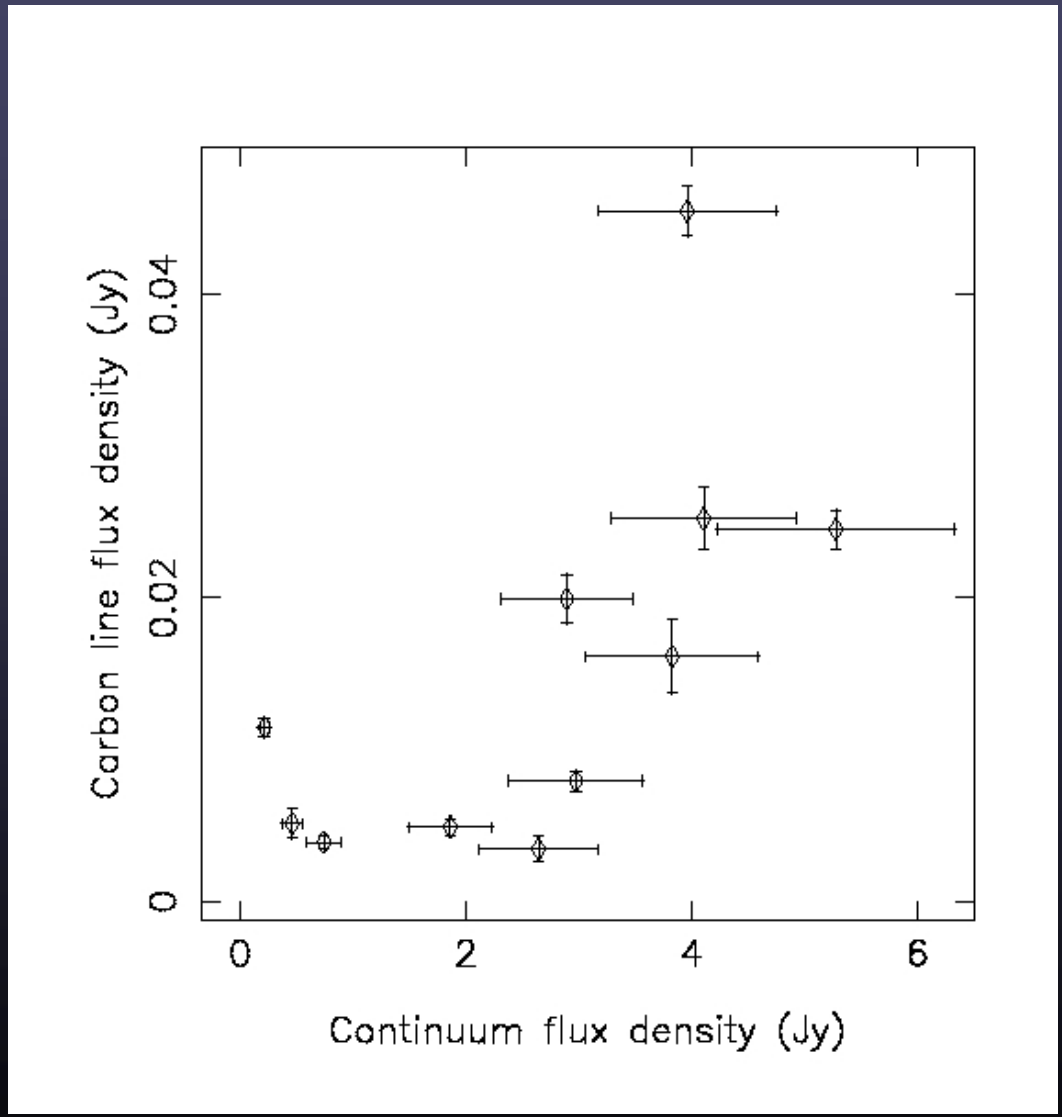
Arecibo Observatory

Radio Recombination Line Data

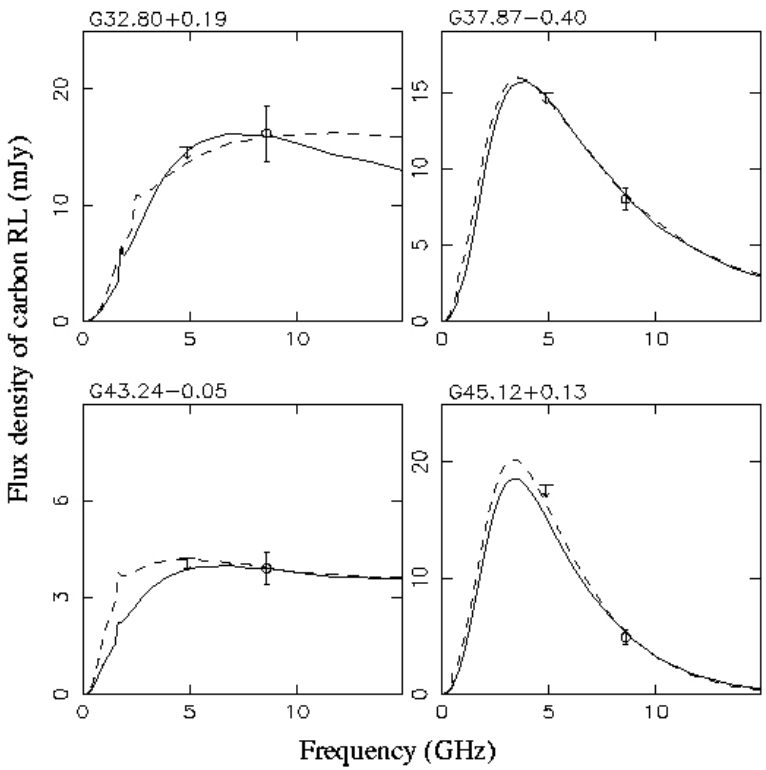


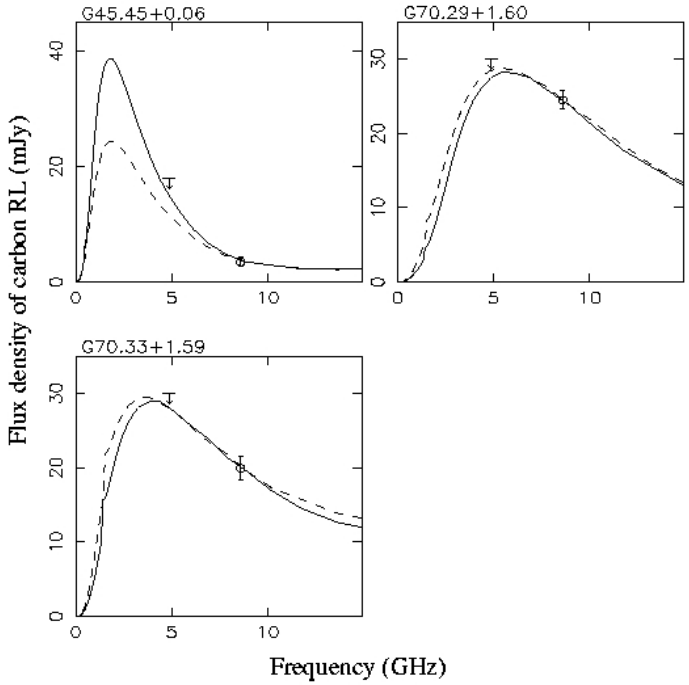


Stimulated Emission

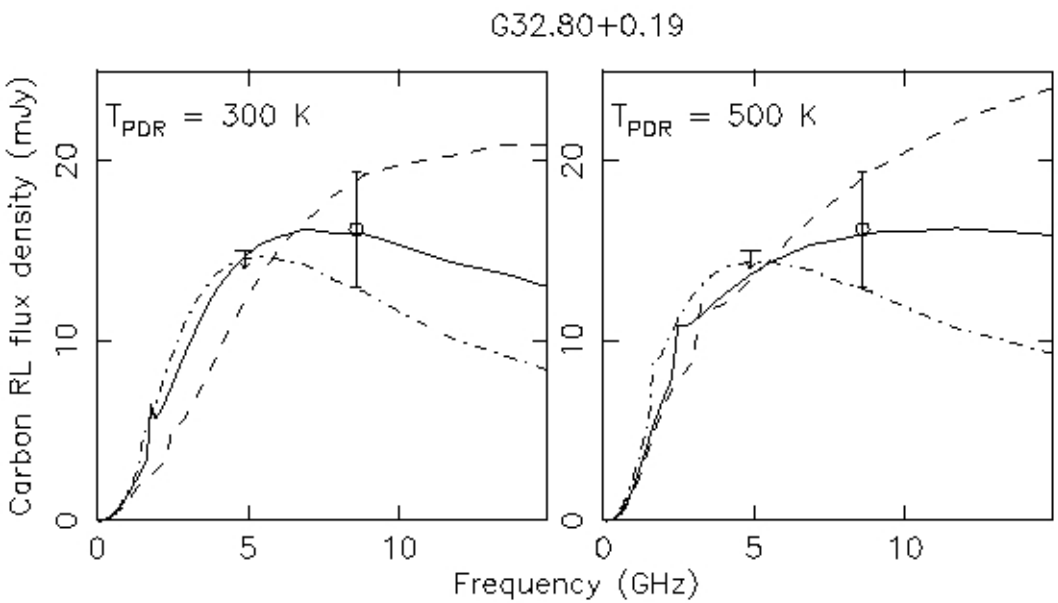


PDR Models


G32.80+0.19
G37.87−0.40
G43.24−0.05
G45.12+0.13
Flux density of carbon RL (mJy)
Frequency (GHz)


G45.45+0.06
G70.29+1.60
G70.33+1.59
Flux density of carbon RL (mJy)
Frequency (GHz)

PDR Model Uncertainty



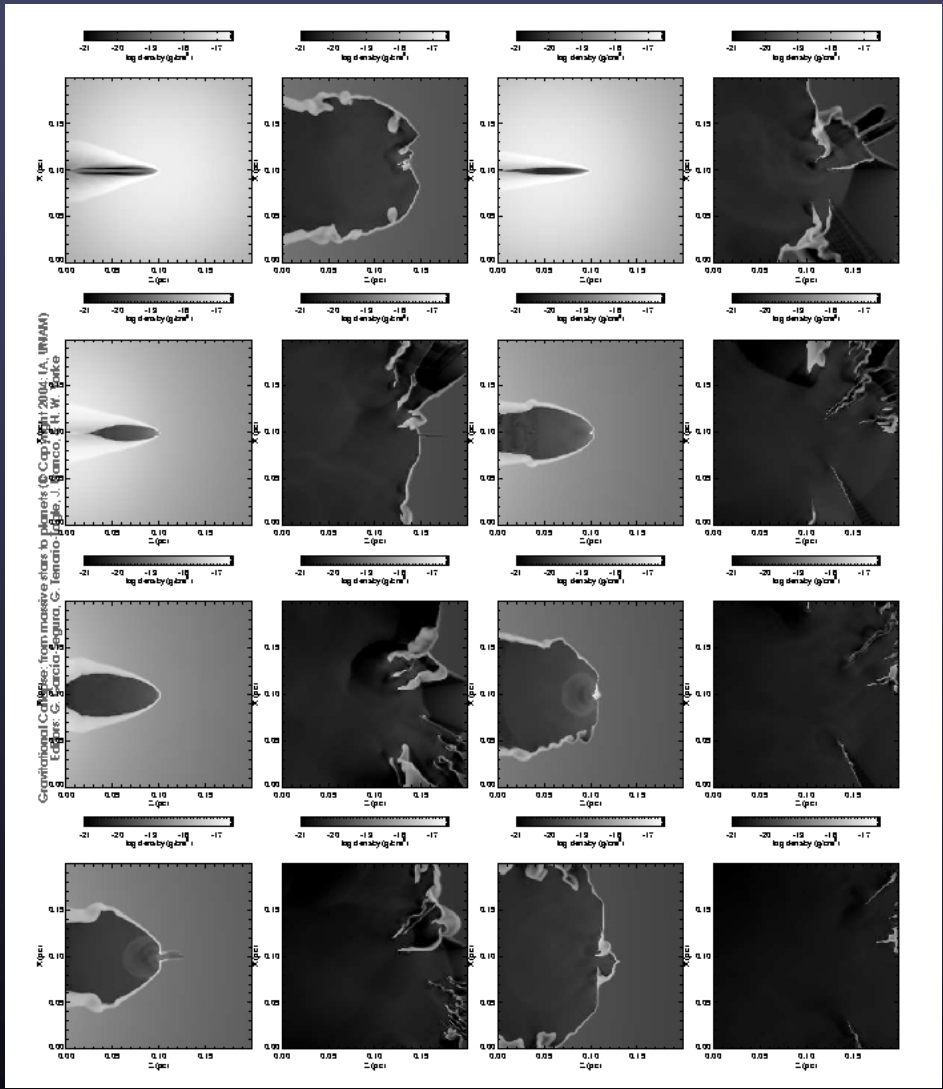
Main Results

- We can detect C RRL emission towards UC HII regions.
  (11 detections in 17 sources – 65%.)

- RMS velocity difference of 3.3 km/s (carbon in PDR versus UC HII).
  (This is half the value measured with molecular lines.)

- PDR pressure is ten times UC HII region pressure.
  (This is consistent with pressure confined HII region model.)

Dynamical Evolution of HII Regions



Garcia-Segura & Franco (2004)