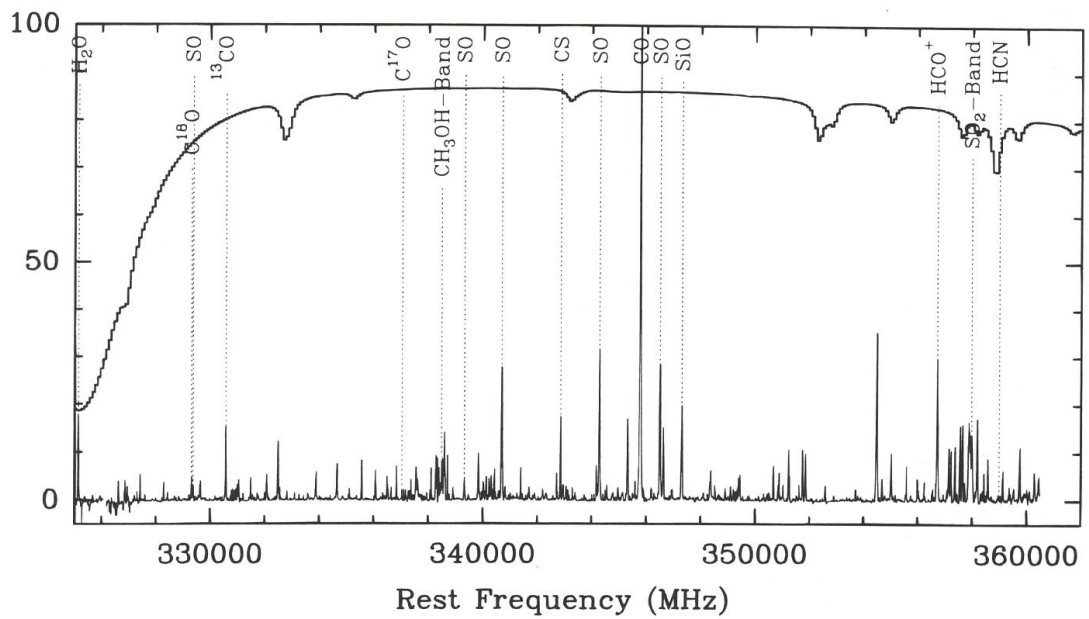
# Molecular gas

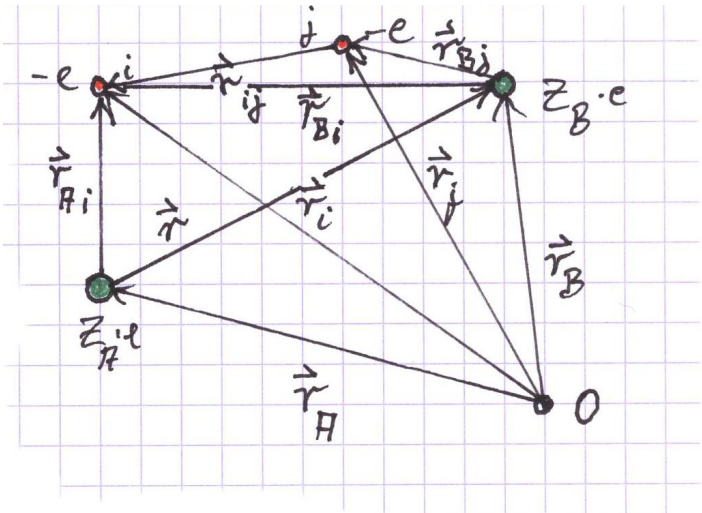
below : frequency survey in Orion KL at $\lambda$ = 1 mm (CSO)

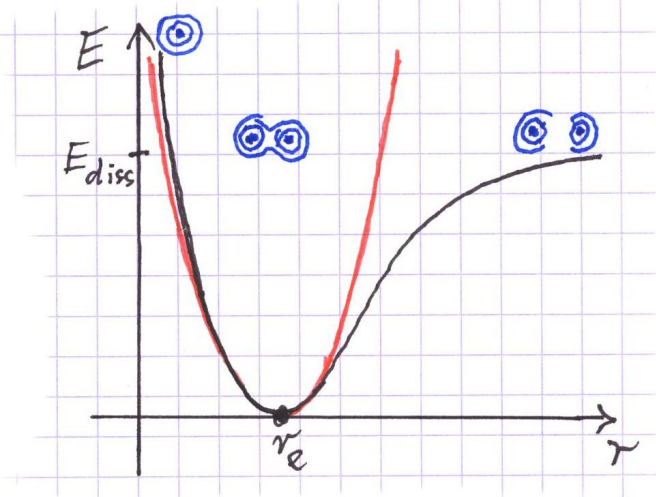
right : frequency survey, taken towards IRC+10216, a carbon star with ist circum-stellar envelope (Mopra telescope)



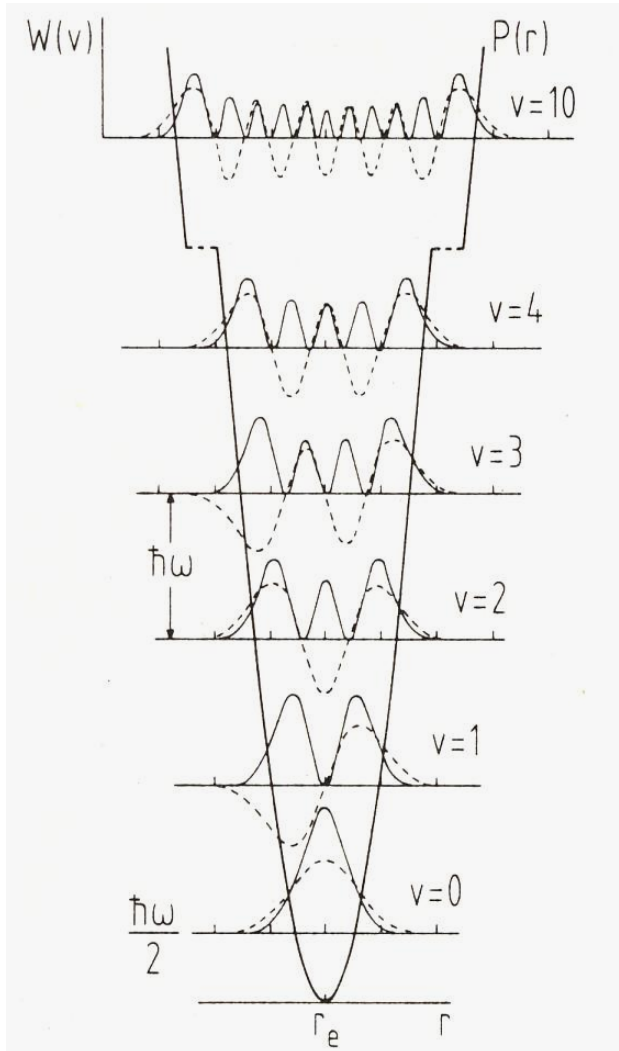
# Molecular gas

Coulomb interactions and potential energy of diatomic molecule (right)



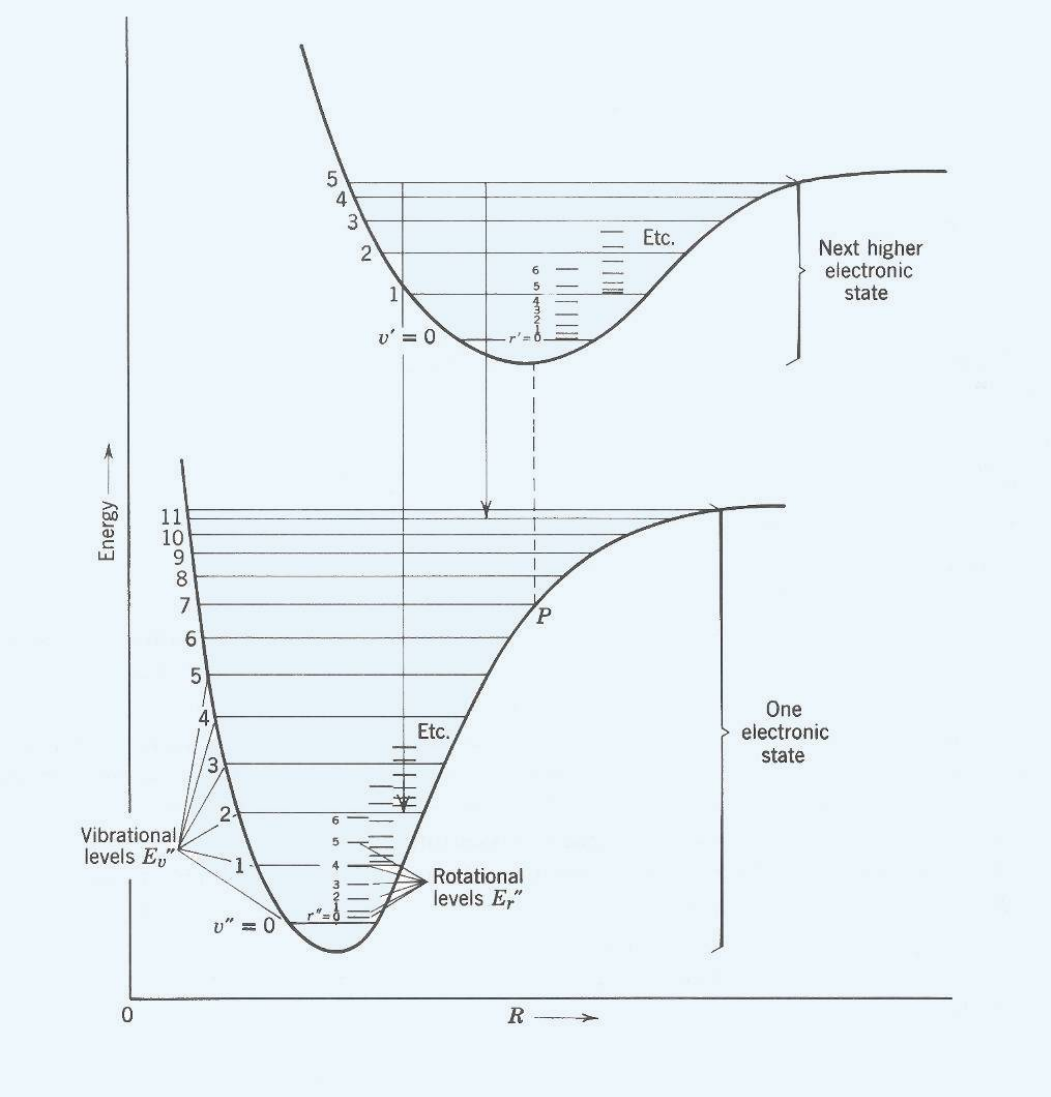




Potential and eigenfunctions of harmonic oscillator (below)

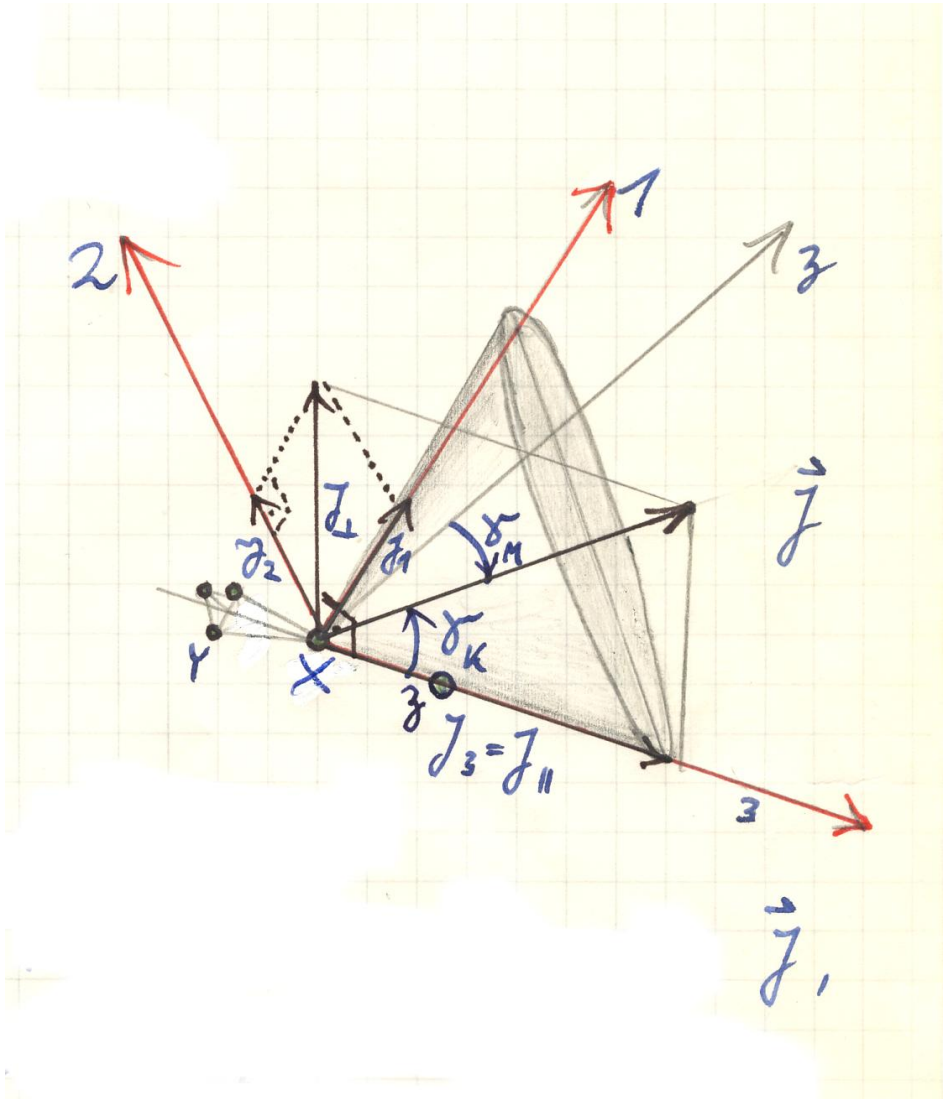


# Molecular gas

Electronic, vibrational and rotational states of a molecule

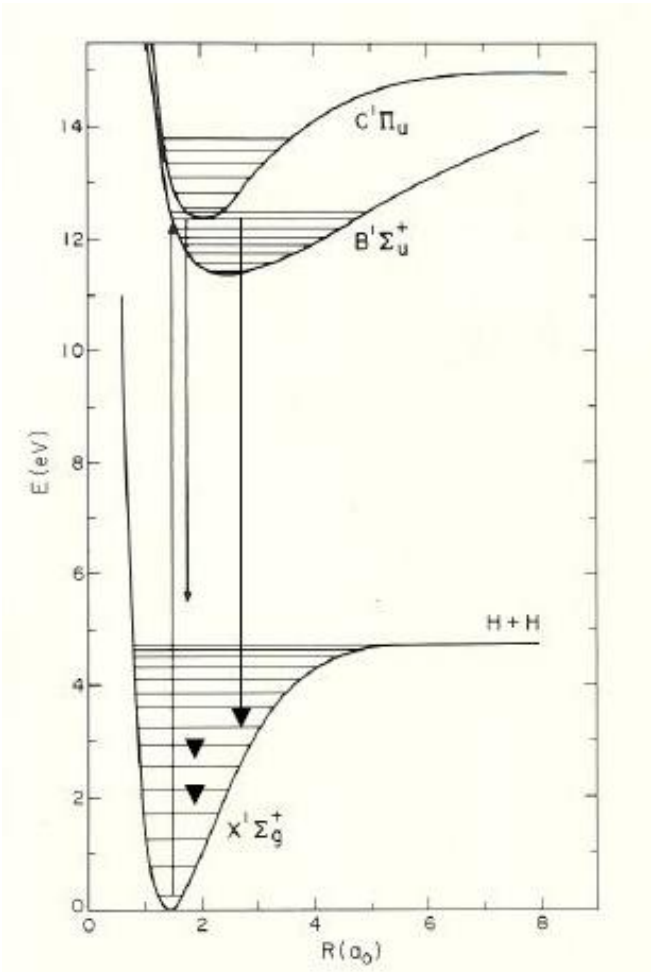


Angular momenta and principal axes of symmetric top

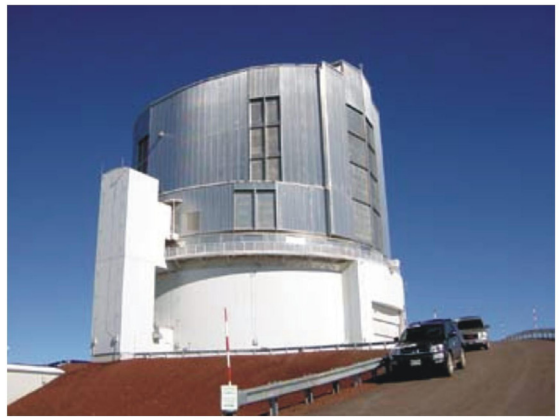


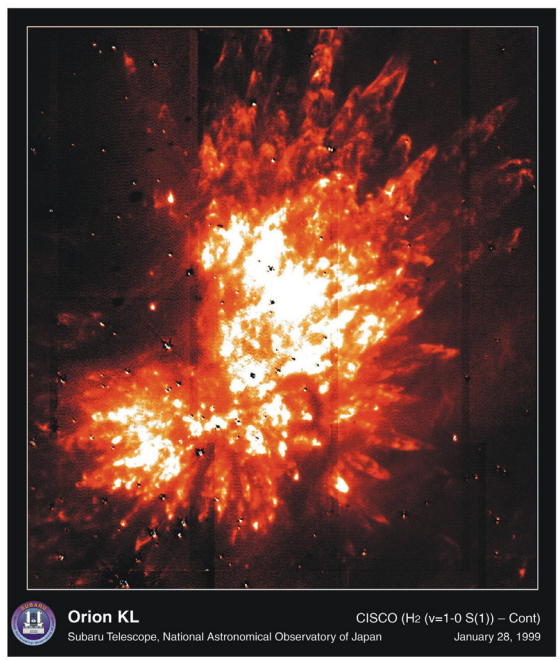
# Molecular gas

Electronic, vibrational and rotational states of H2




H2 emission from Orion KL (Subaru telescope)

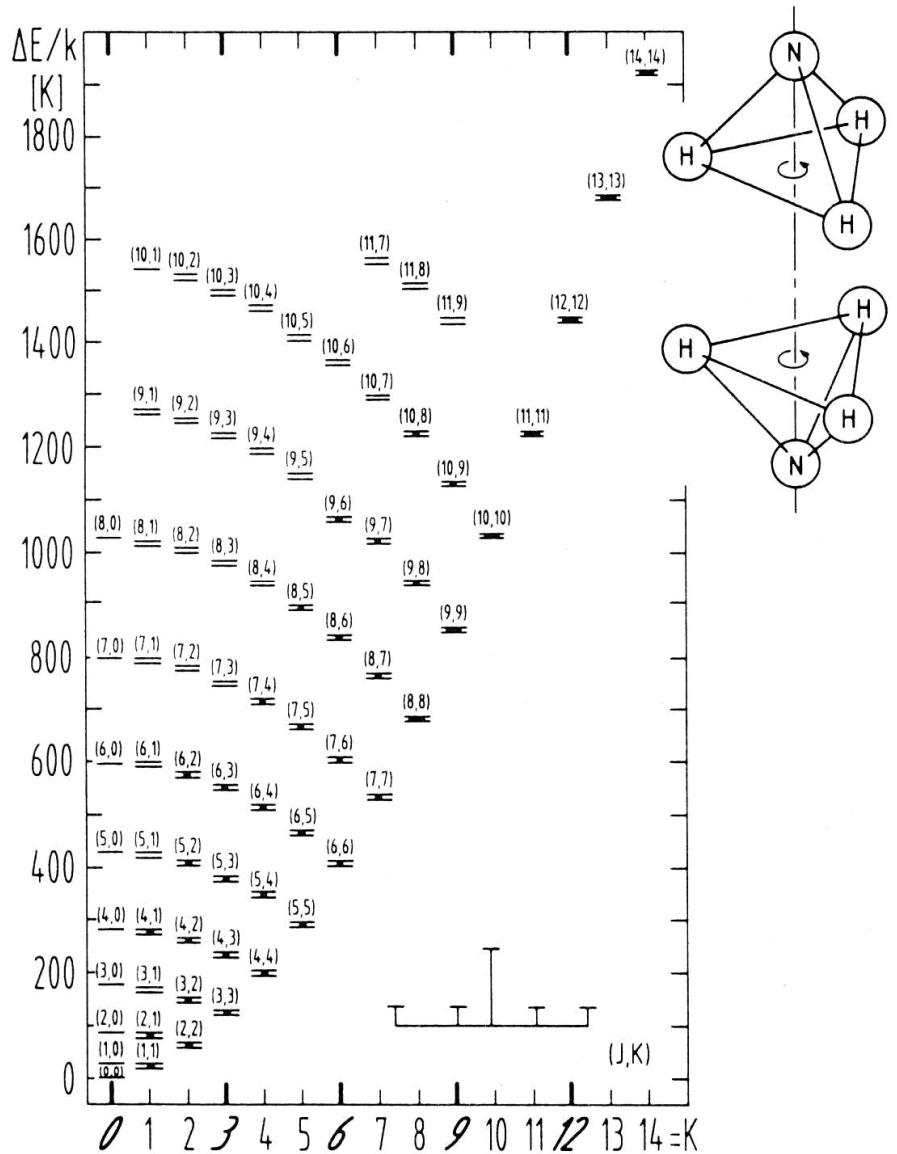




# Molecular gas

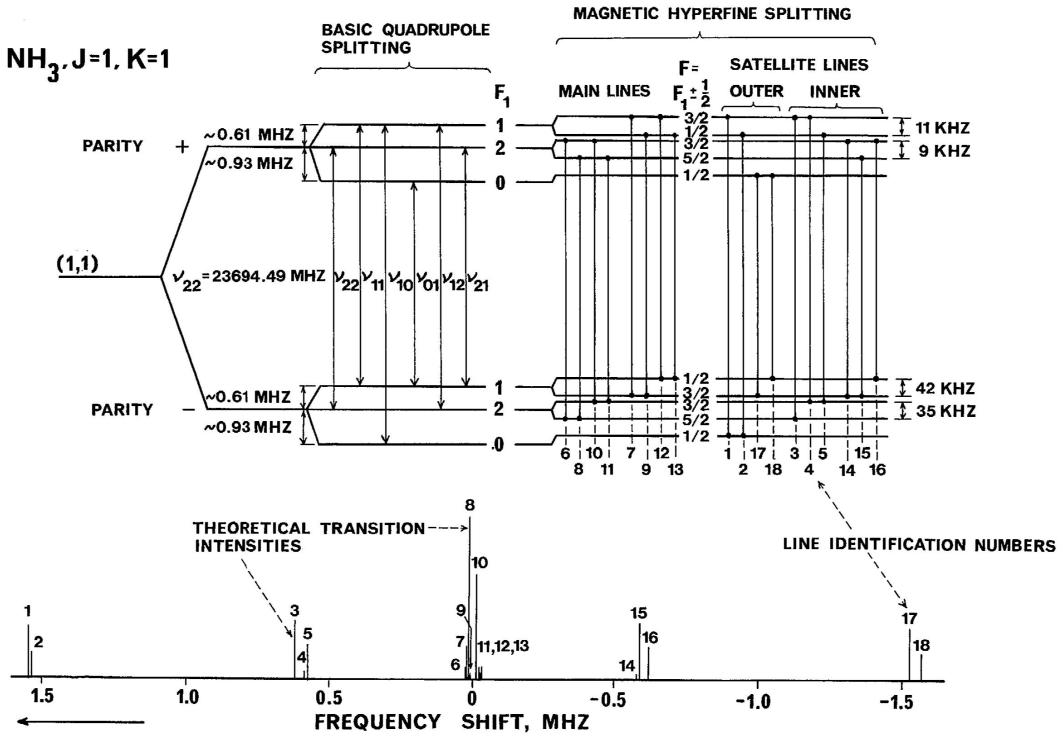
energy levels of $NH_3$

quantum numbers are
*J* and *K*

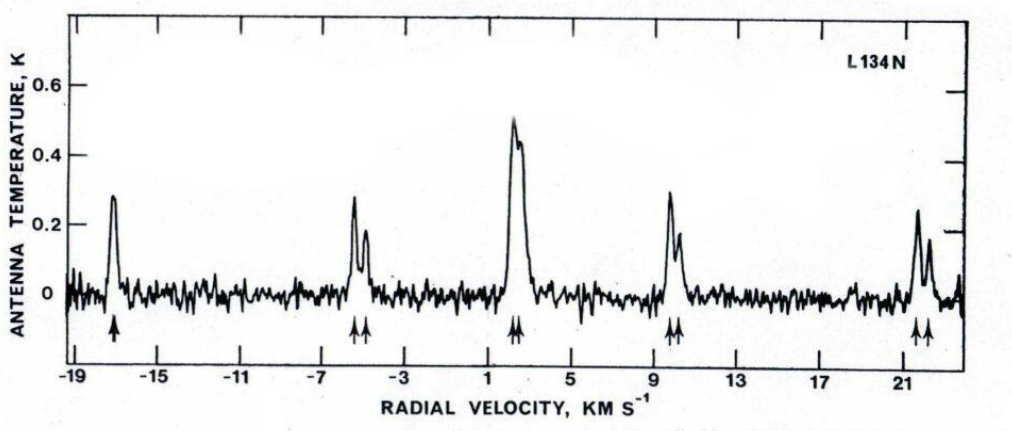


# Molecular gas

transitions and theoretical spectrum of $NH_3$

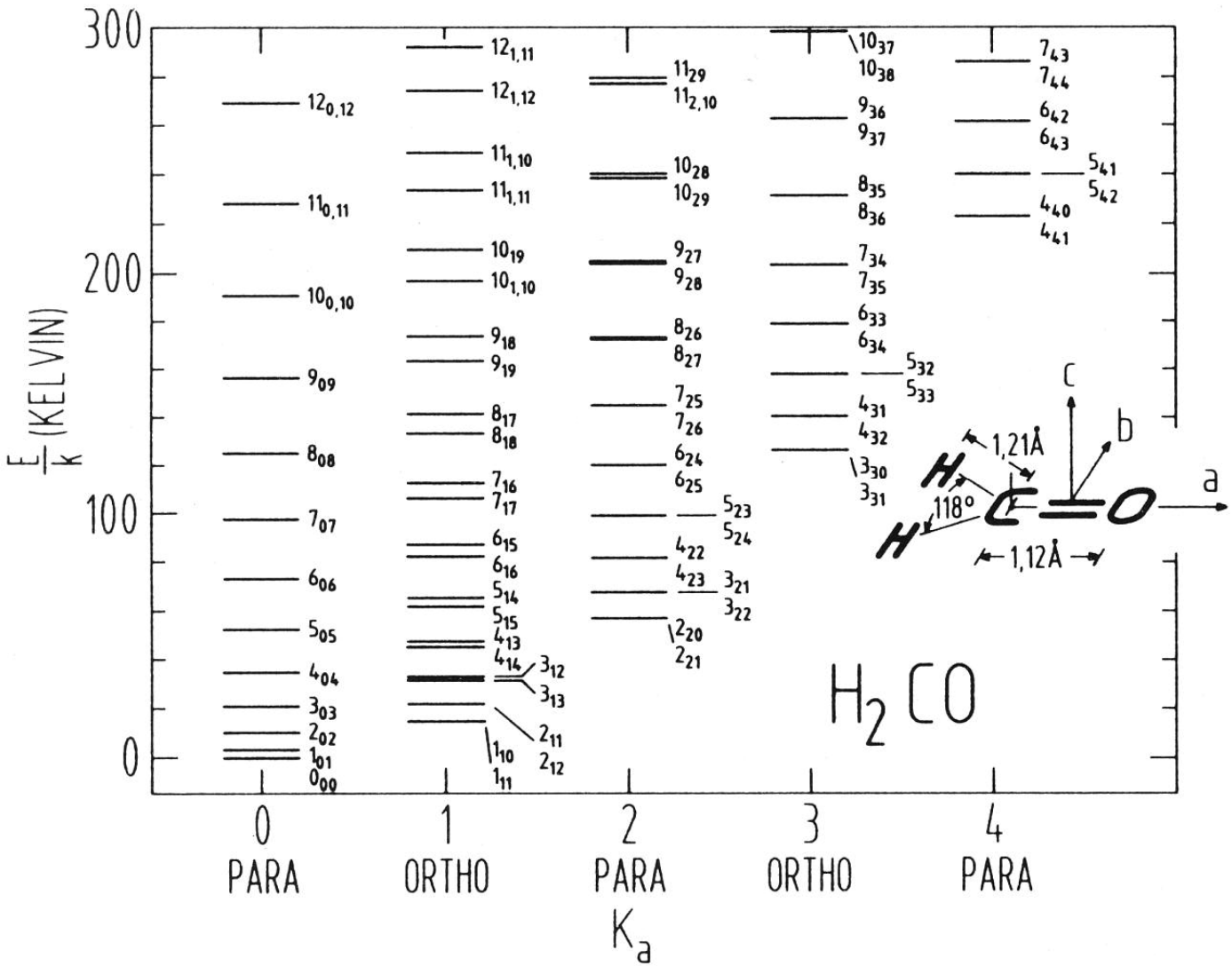



observed (1,1) spectrum of $NH_3$



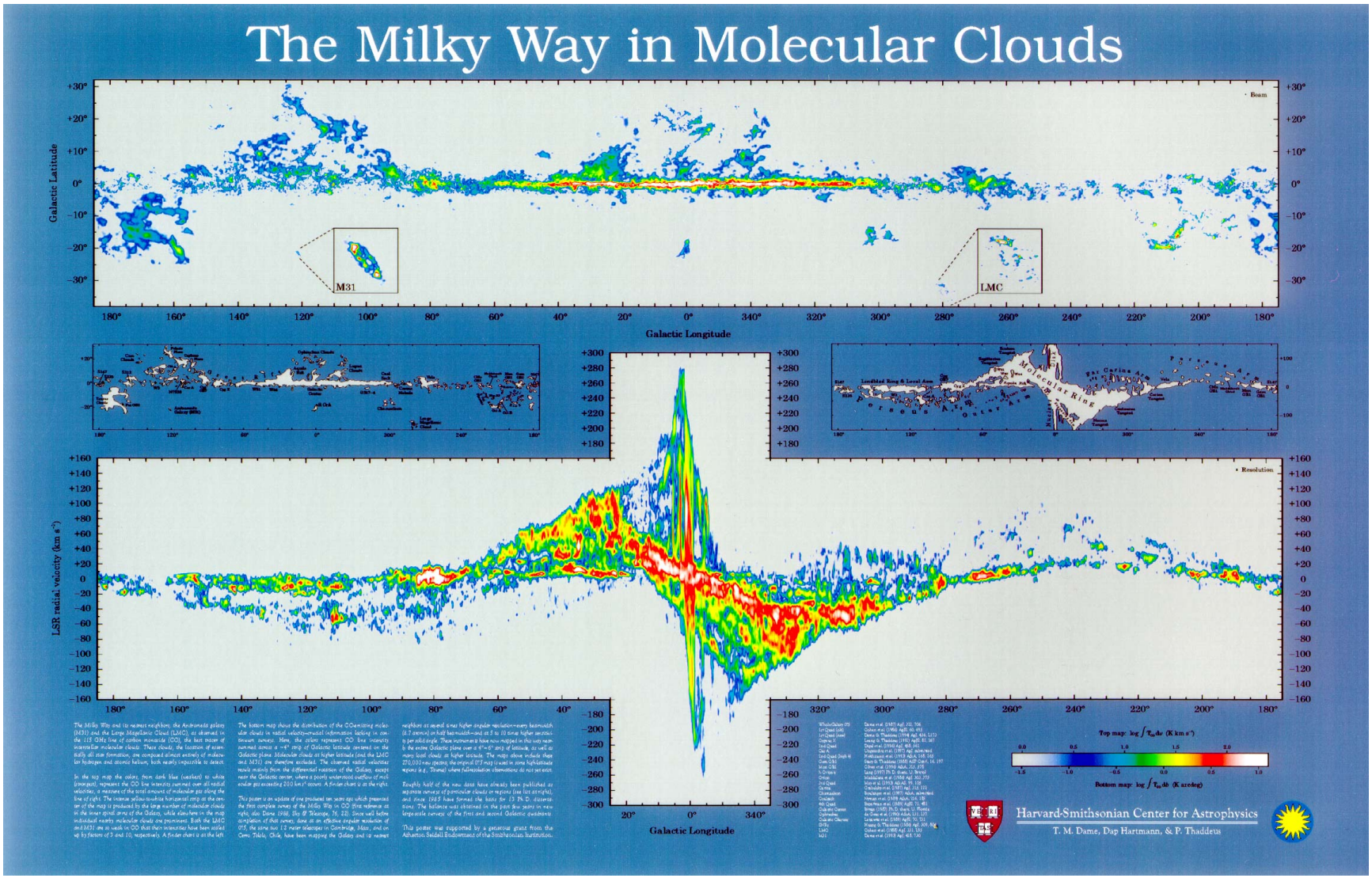
# Molecular gas

energy levels of $H_2CO$; quantum numbers are $J_{K_A K_C}$



# Molecular gas

CO(1→0) survey of the Galactic plane (Dame et al.)
upper panel: intensity; lower panel: velocity

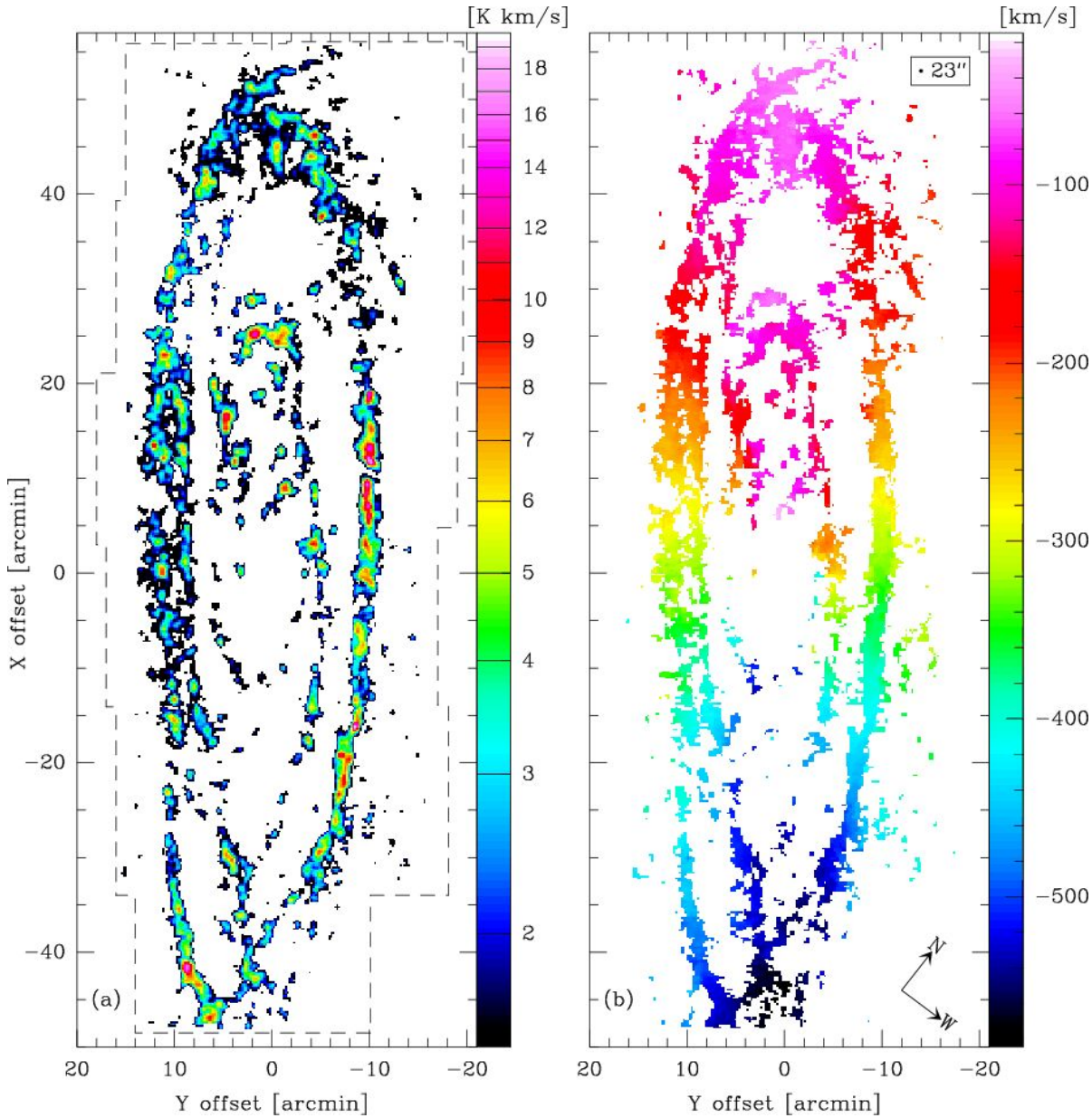


# Molecular gas

CO(1→0) survey of M31 (Guelin et al.)

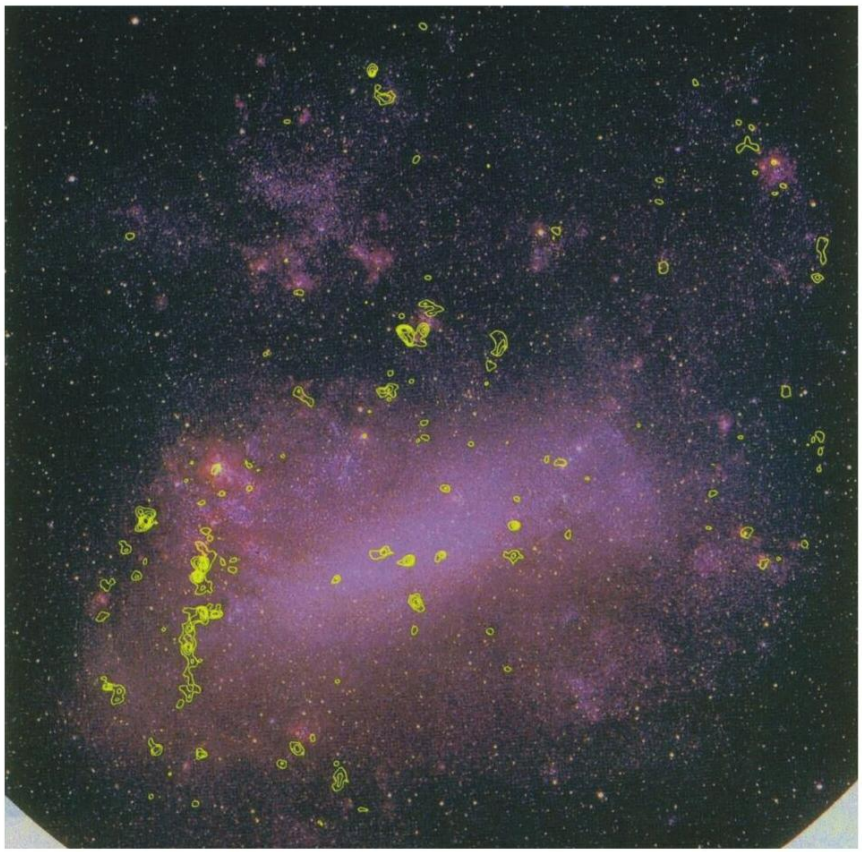
left: intensity

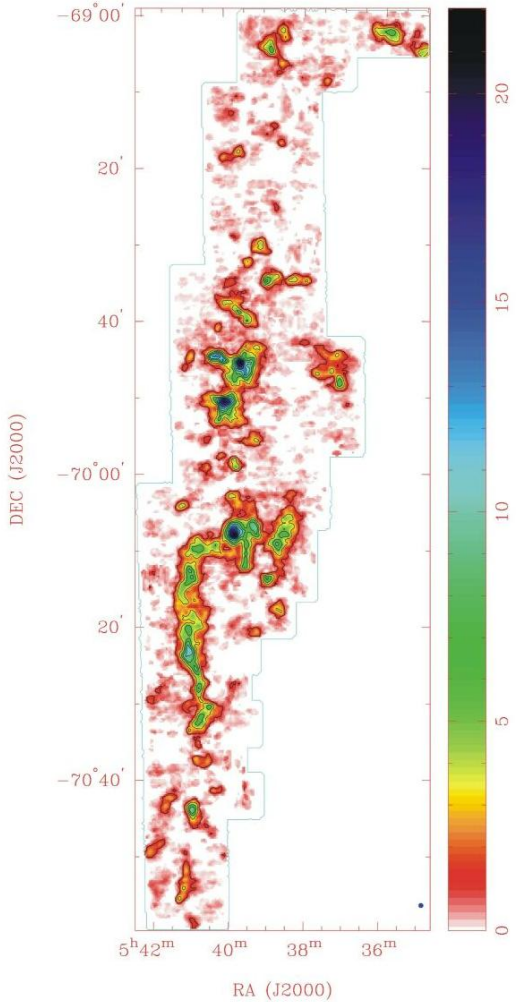
right: velocity



# Molecular gas

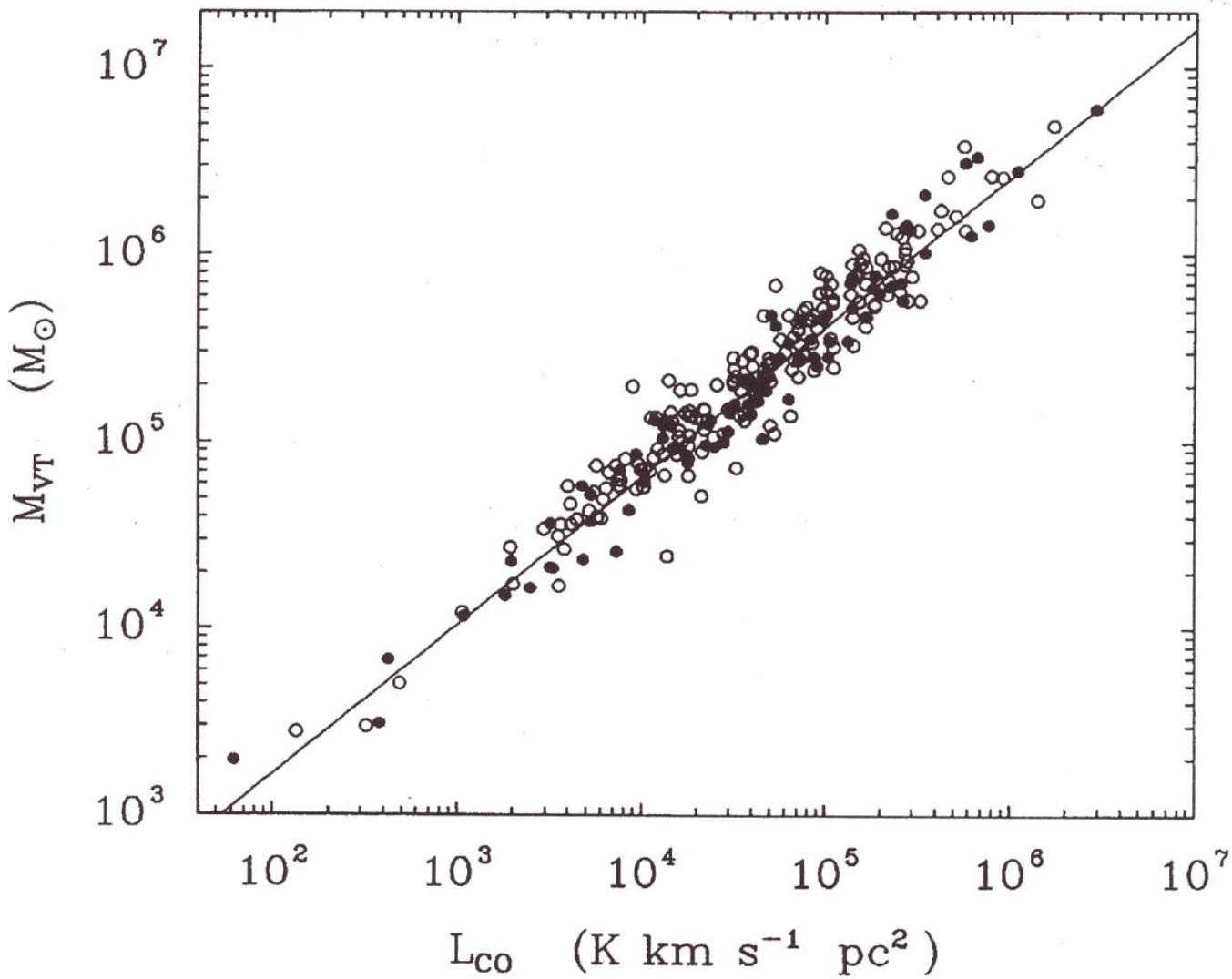
CO(1→0) maps of the LMC; total map at 2.6' resolution (left, yellow contours on optical image), observed by Fukui et al. with the NANTEN telescope, and map of the “molecular ridge“ at 40" resolution (right), observed with the Mopra telescope by Pineda et al.)



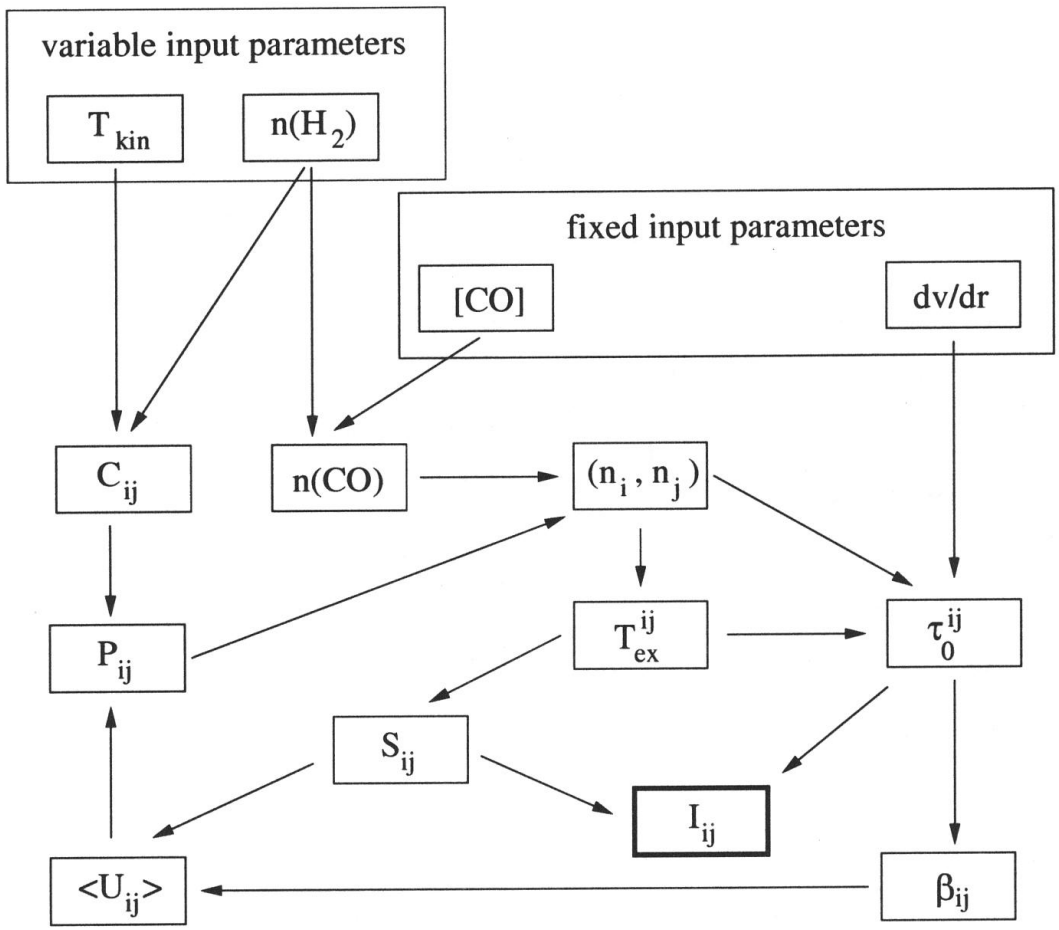


# Molecular gas

Relation between virial mass and CO luminosity of Galactic molecular clouds

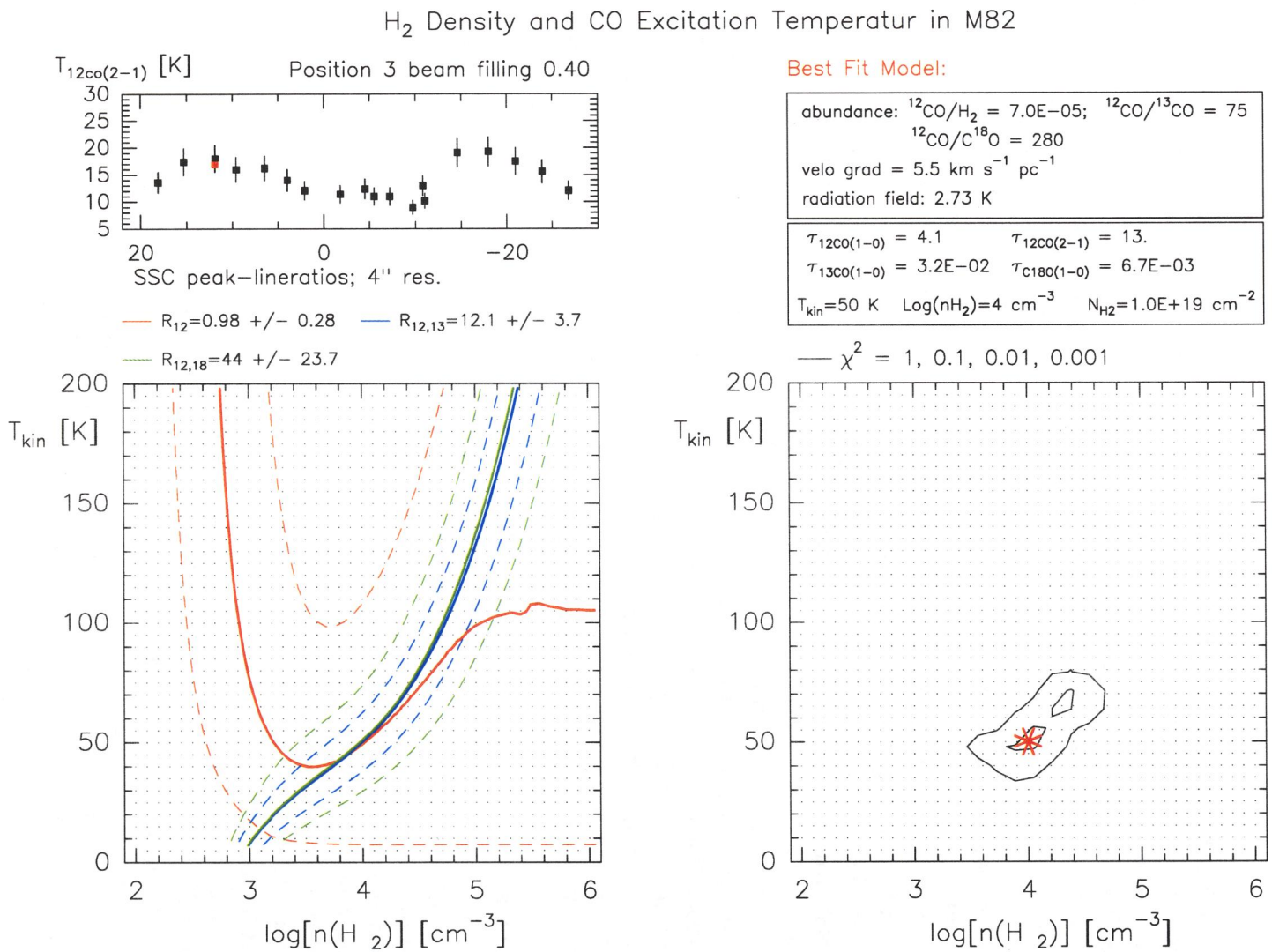


Flow diagramme of LVG calculation



# Molecular gas

## Results of LVG analysis in the starburst galaxy M 82



# Molecular gas

Distribution of the molecular hydrogen in the starburst galaxy M 82 as derived with three different methods:

- LVG analysis
- LTE solution
- application of constant $X_{CO}$

Note the large differences, probably due to varying excitation conditions across the galaxy, rather than to that of the $H_2$ column density