Diagnostic Emission Line Ratios

A. Siviero

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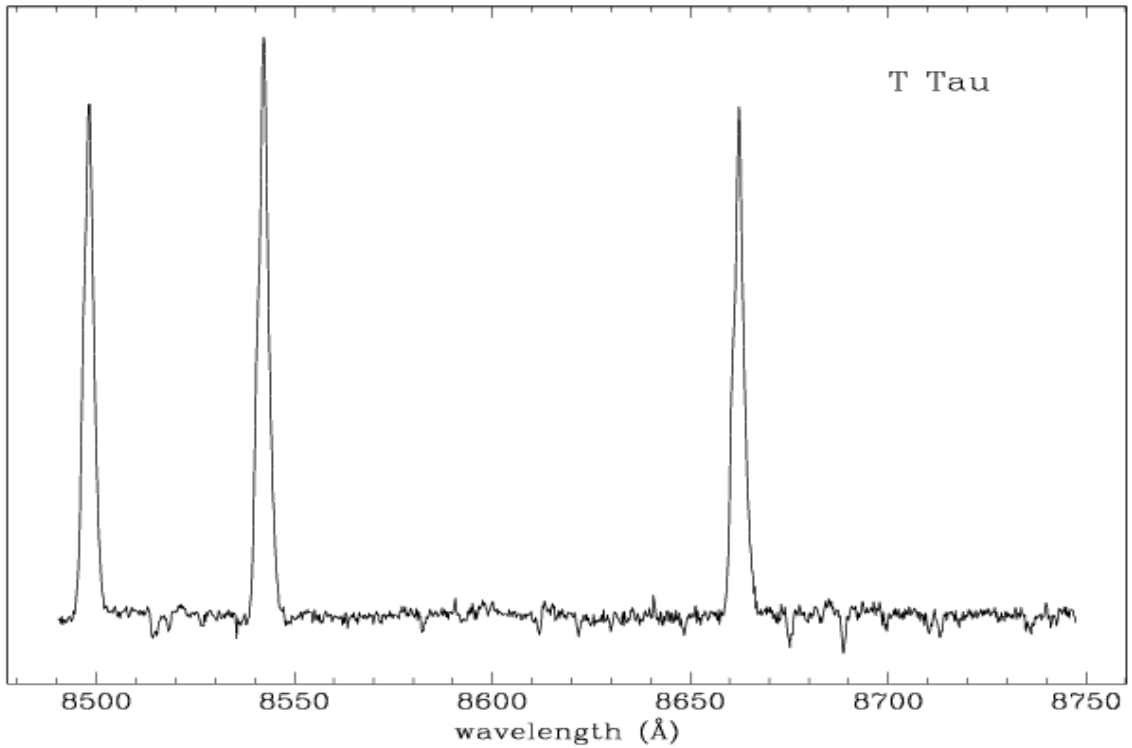


emission lines in the GAIA spectral range

CaII 8498.018	HeI 8518.033	FeII 8499.606	NI 8567.735	SI 8617.090
8542.389	8529.025	8504.033	8594.000	8655.173
8662.140	8531.508	8508.659	8629.235	8670.589
	8564.763	8522.599	8655.878	8671.281
P13 8666.421	8581.856	8582.723	8680.282	8678.927
P14 8599.794	8582.670	8593.842	8683.403	8679.620
P15 8545.984	8584.369	8609.506	8686.149	8680.411
P16 8502.987	8608.312	8636.587	8703.247	8693.137
	8632.770	8722.459	8711.703	8693.931
FeIII 8509.061	8648.258		8718.837	8694.626
8512.713	8650.811	AlII 8640.699	8728.901	
8515.301	8662.171			
8563.493	8729.893	MnI 8740.930		
8568.418	8733.434			

compact planetary nebulae and pre - ZAMS
are among the most numerous point-sources objects
whose spectra are dominated by emission lines
that we may expect to be detected by GAIA

the simplest case to treat is the Planetary Nebulae

what can we expect to derive from their emission line spectra in the GAIA range ?

The potential is limited by the absence of forbidden lines in the GAIA wavelength range (like the well known [OIII], [NII], [SII] in the optical), and much of the analysis has to relay on CaII and Paschen lines + a few weaker ones from FeII or HeI ect.

radial velocity

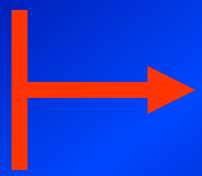
T central star

gas electron density

gas electron temperature

gas expansion kinematic

gas chemical composition
(too narrow wavelength range)



age of the planetary nebula

to explore the reponse of the emission line spectrum to these input parameters, I used the well know CLOUDY program

What can CLOUDY do ?

Cloudy is designed to simulate emission line regions ranging from the intergalactic medium to the Broad Line Regions of Quasars

it can be used to predict either the structure or the observed spectrum from such regions

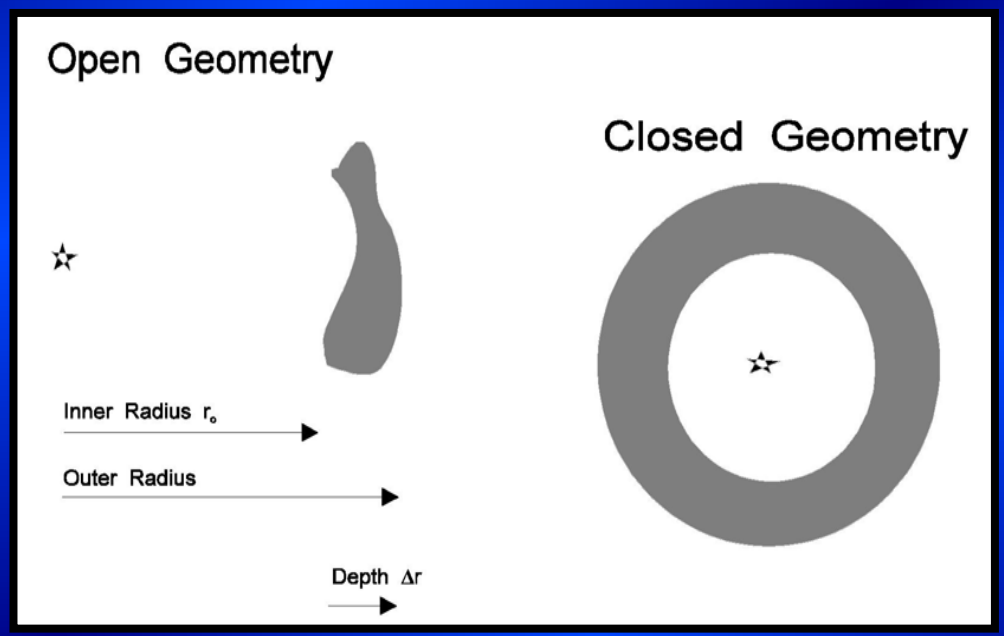
this is done by simultaneously solving the equations of statistical and thermal equilibrium, and equations that balance ionization-neutralization and heating-cooling processes

What must be specified ?

type and intensity of the incident continuum

gas chemical composition

geometry



velocity structure (turbulence or wind can be added)

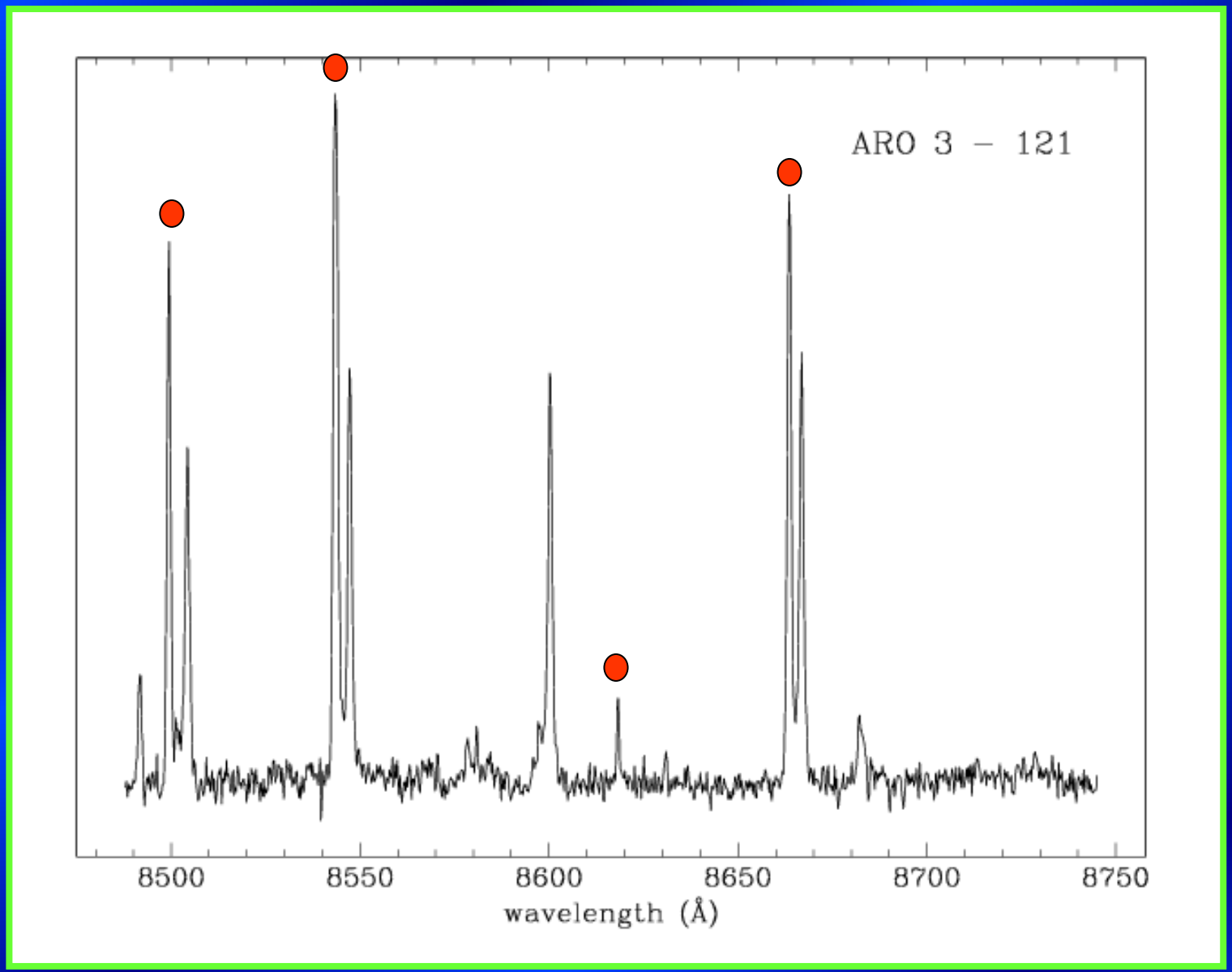
What is computed and printed ?

Cloudy works by dividing a spherical nebula into a set of thin concentric shells (zones)

typically ~100 to 200 zones are computed in a optically thick model

for every zone temperature, distance from the source and some other properties of the solution are given

… typical Planetary Nebula



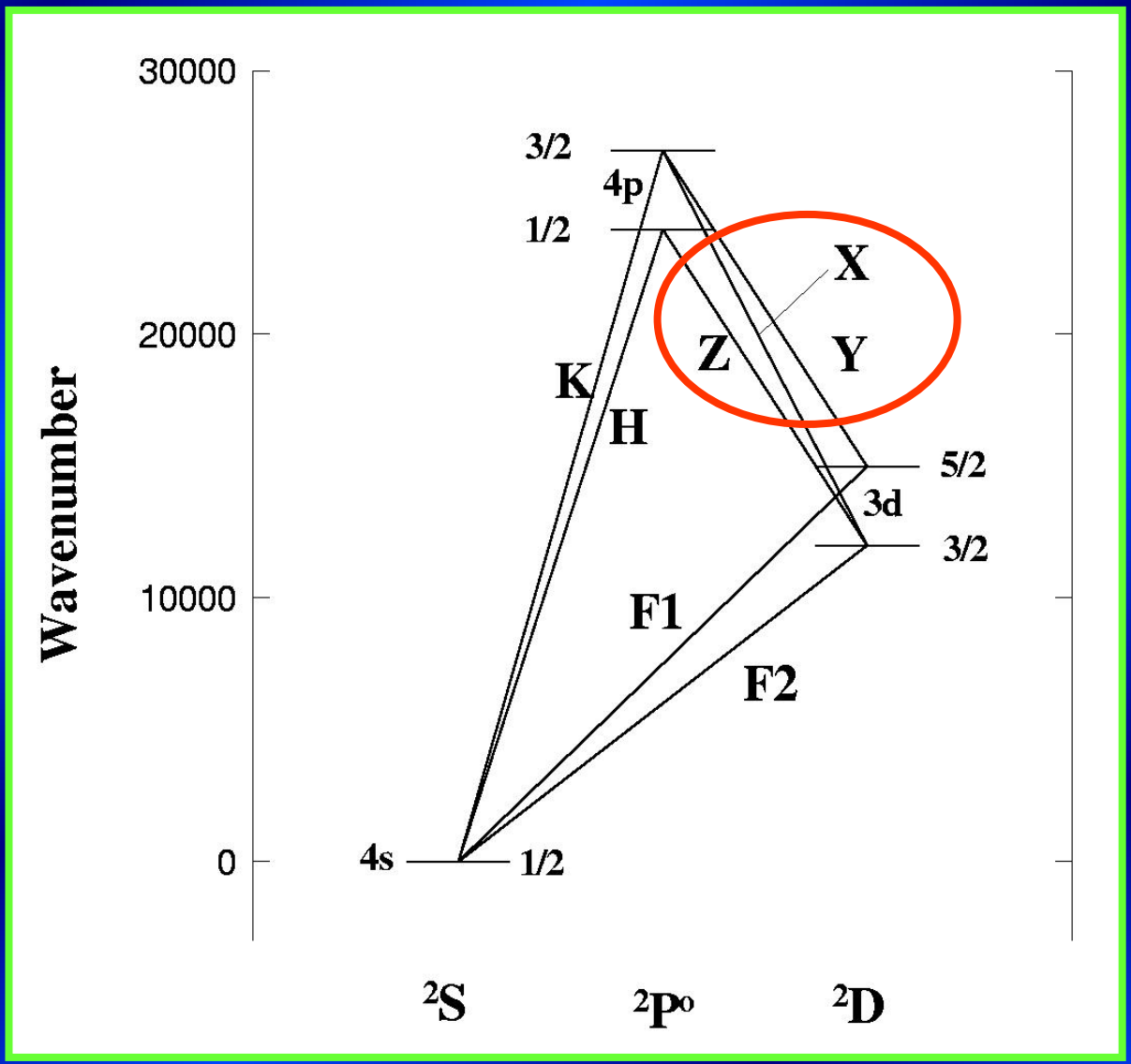
the CaII infrared triplet

CaII X
8498 Å

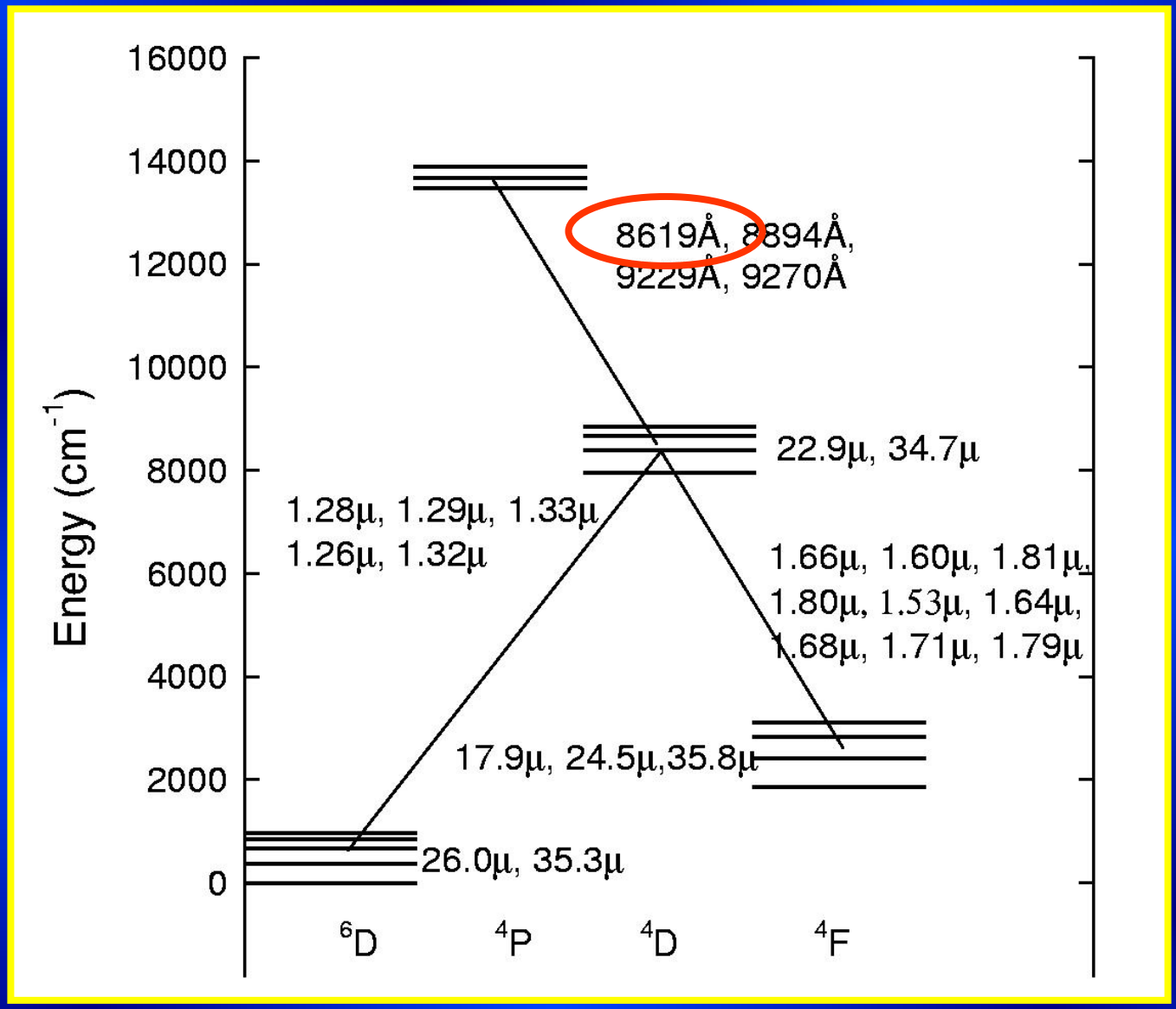
CaII Y
8542 Å

CaII Z
8662 Å

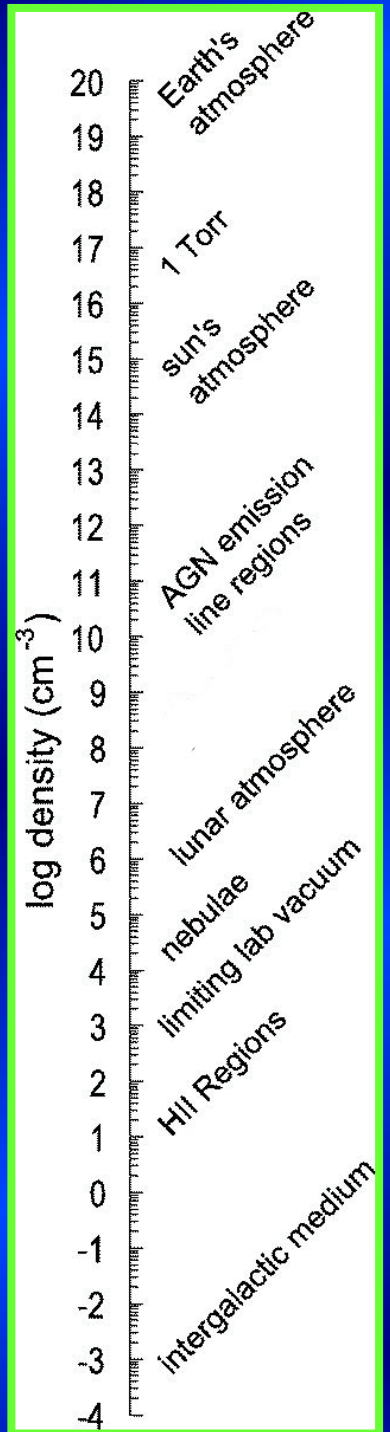
from a five level atom

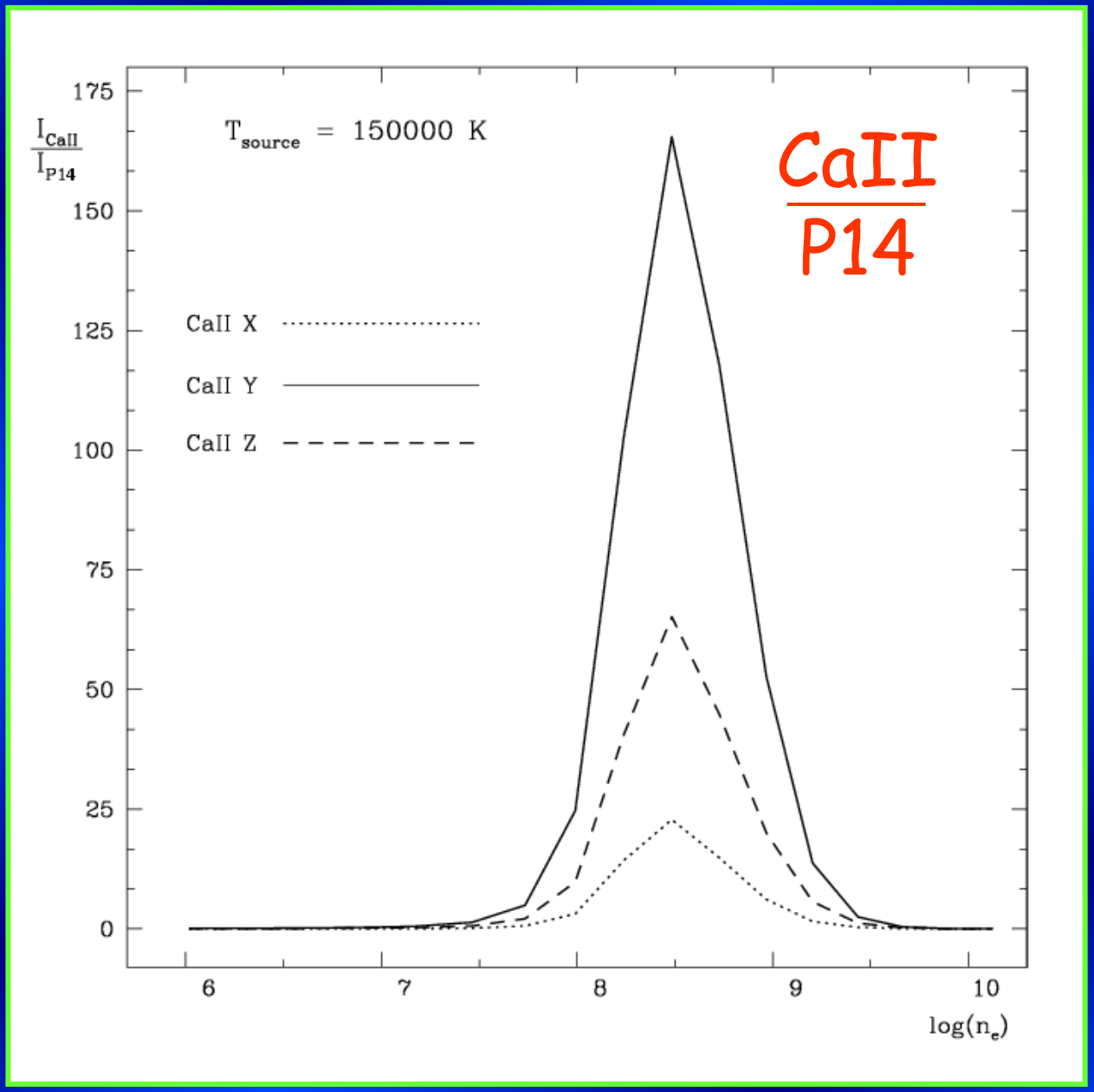


… and the 8619 Å line from a sixteen level FeII atom

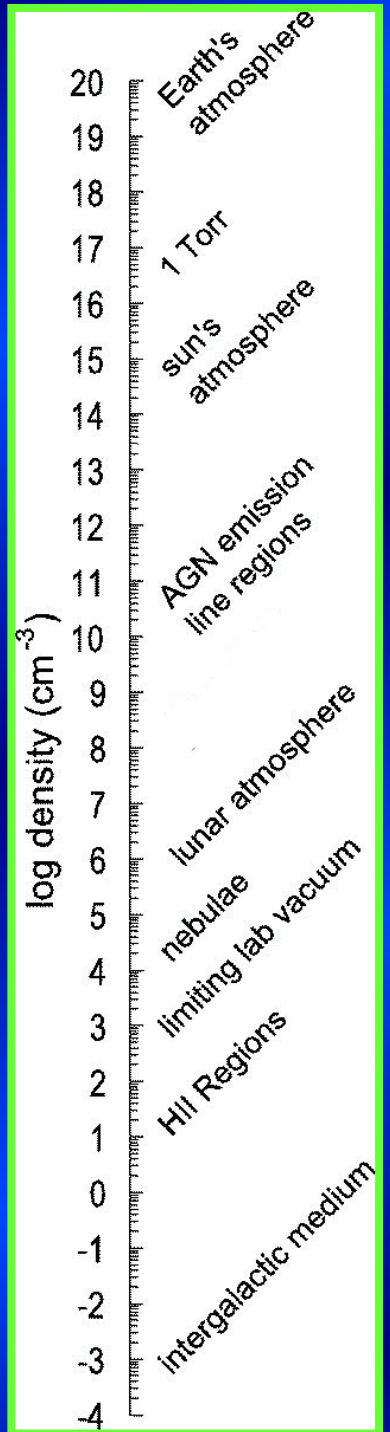


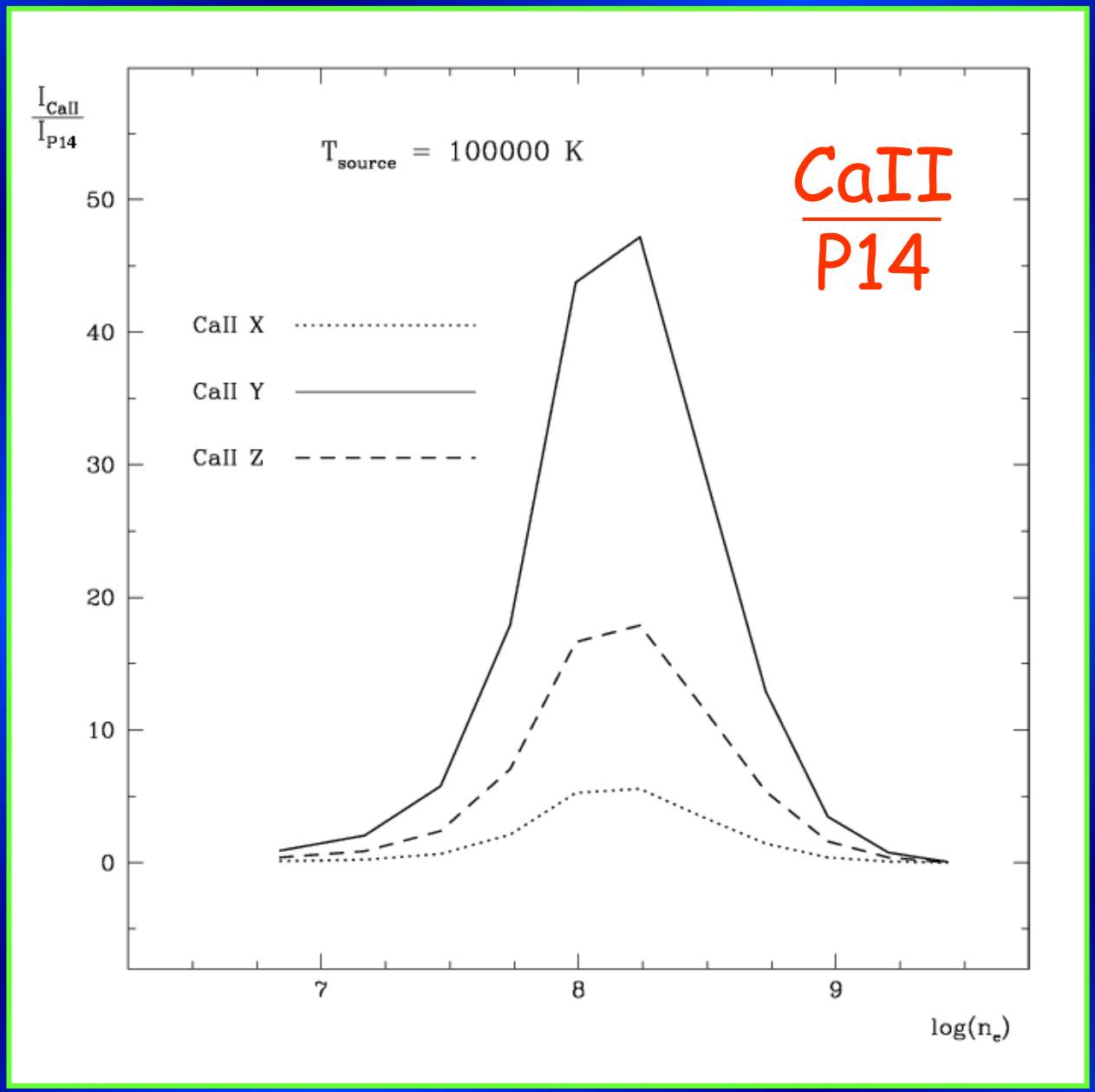
the CaII infrared triplet



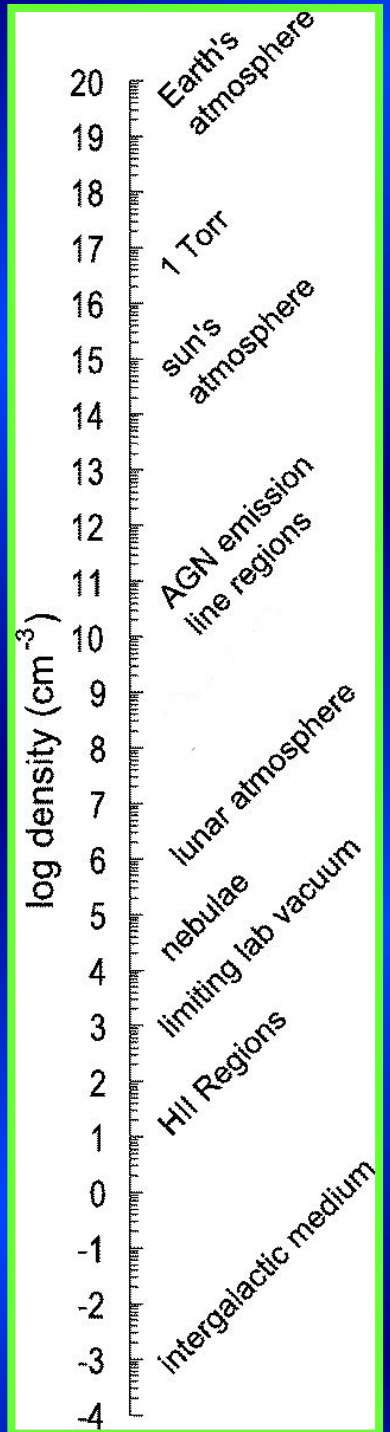


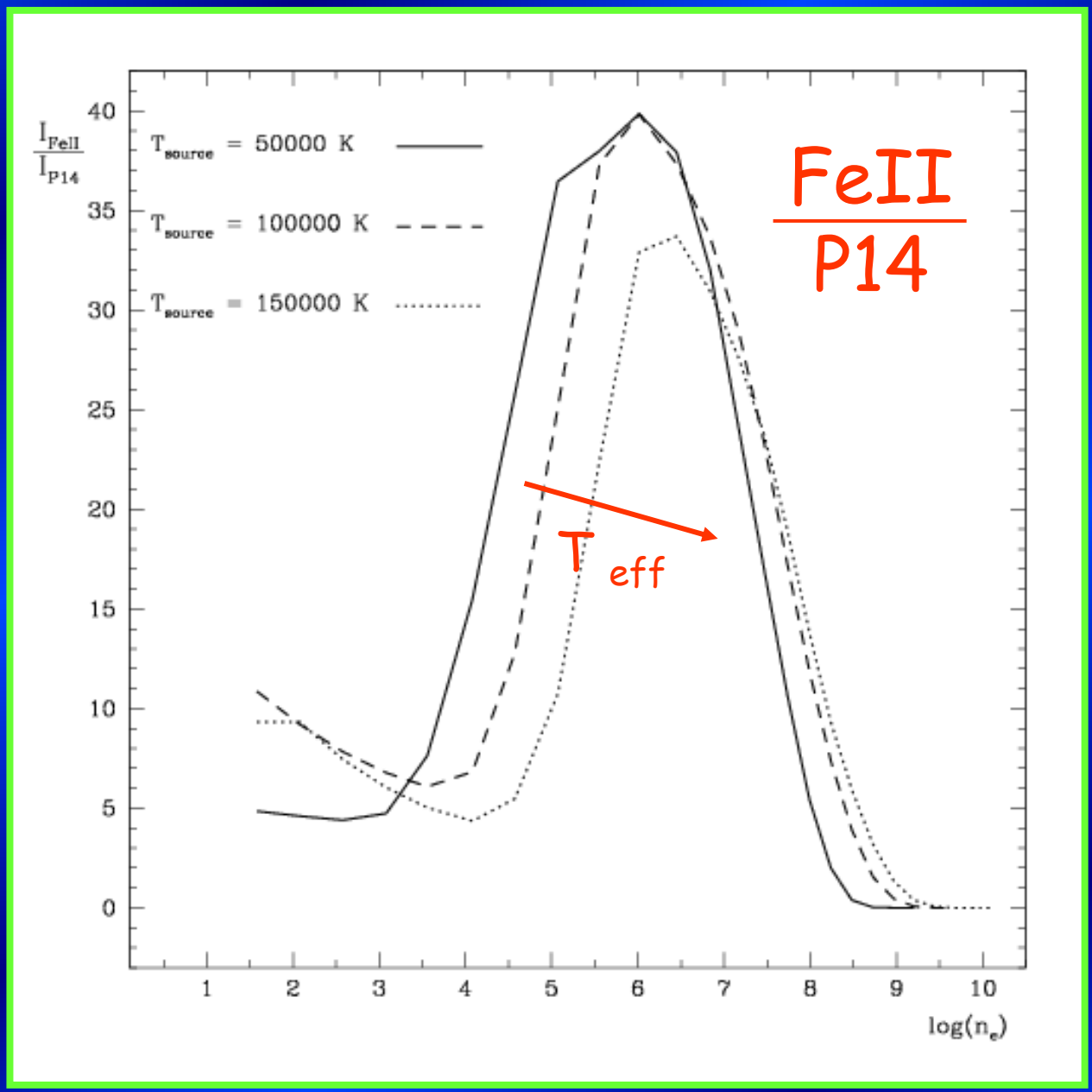
the CaII infrared triplet

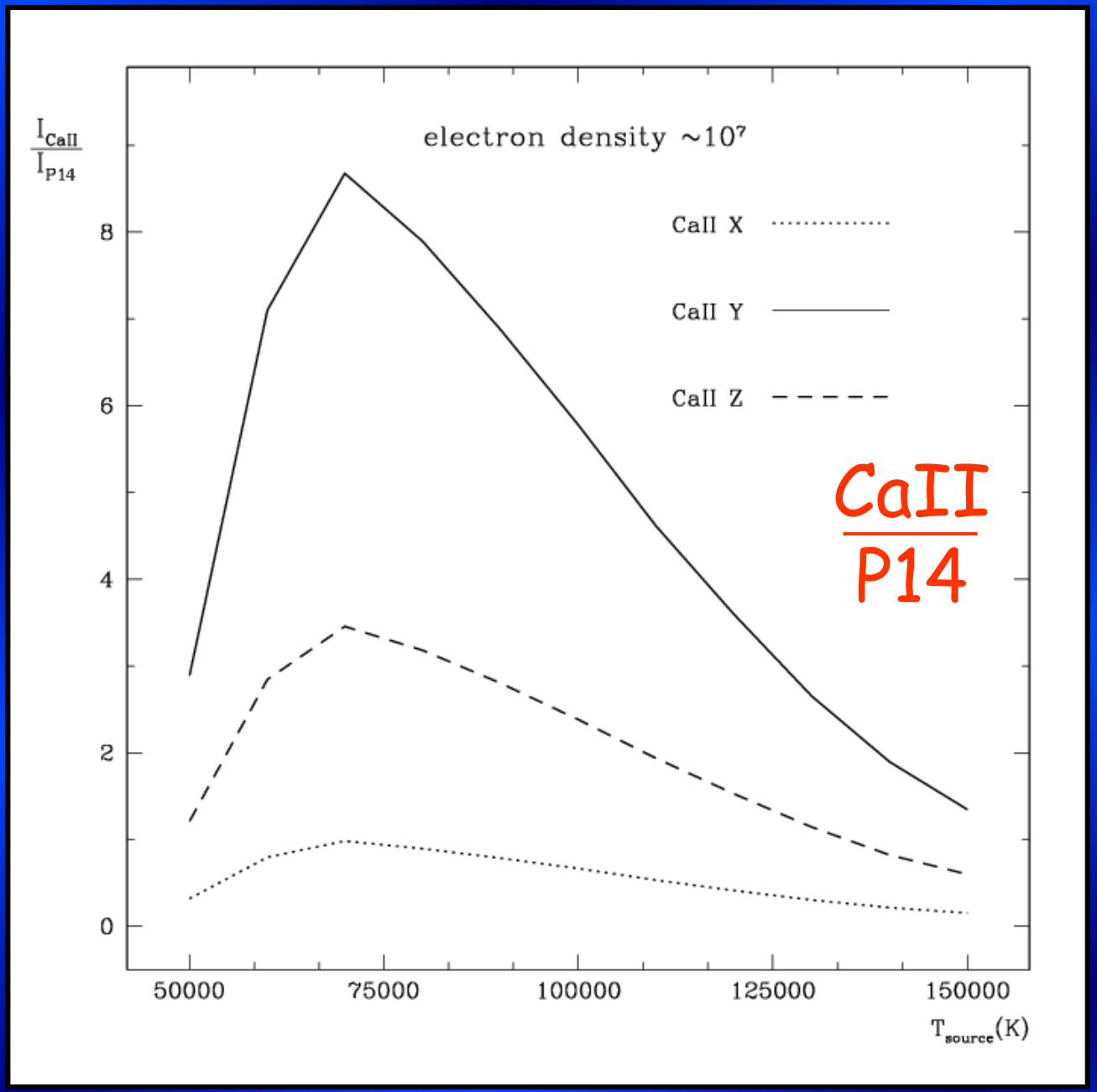




the FeII 8619 multiplet






electron density ~10⁷
I_CaII / I_P14
CaII X
CaII Y
CaII Z
CaII / P14
0
2
4
6
8
50000
75000
100000
125000
150000
T_source(K)

conclusions

this is a first attempt to derive physical conditions of nebular region from diagnostic of intesity ratios of emission lines in the GAIA spectral range

at moment we have tested only a couple of lines (CaII and FeII over Paschen 14) in a simple and typical case of planetary nebulae, obtaining encouraging results

the project goal is to obtain a complete set of diagnostic ratios for a large sample of nebular conditions and validate it by comparison with real emission spectra we plan to secure with the refurbished Asiago Echelle spectrograph.

the symbiotic stars