A PHOTOIONIZATION MODEL STUDY OF NGC 7027

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The physical characteristics of NGC7027 and the nature of the observations available make it an exceptional object to check the ability of steady photoionization modelling to correctly predict the emission spectrum of nebulae. After a decade of atomic physics and observation improvements, a complete updating of the analysis performed by Péquignot et al (1978) (Astron. Astrophys. 63, 313) is in order.

We obtain a radiation bounded spherically symmetrical model, in which the central star temperature is about $2x10^5$K. The star must emit less high energy radiation ($h\nu \geqslant 120$ eV) than the stellar atmosphere models of Hummer and Mihalas (1970). The gas pressure is approximately constant throughout the nebula, the mean electron density being $\sim 7x10^4$ cm^{-3}. The helium, carbon and oxygen abundances by number are 0.10, $9.5x10^{-4}$ and $4.6x10^{-4}$ resp. The mean electron temperatures associated to H^+, He^+ and He^{++} are 14700 K, 12500 K and 16700 K resp. The model successfully accounts for most electron density and temperature indicators, suggesting that most collision strengths and radiative transition probabilities used are now essentially correct and that the representation of the nebula is faithful.

By contrast the ionization equilibria are not all perfectly reproduced. The discrepancies do not exceed a factor 2 in most cases, which is more satisfactory than the factors 10 found a decade ago, suggesting that all important physical processes are now taken into account. However the atomic data may not always be of adequate accuracy because most discrepancies cannot be eliminated by considering, e.g., more complex density distributions on either small or large scale. Examples of discrepancies are given in the table.

Ratio	Theo/Obs	Suggested explanation
OII/OIII	/1.4	rate O^{+2} + H too weak
OIV/OIII	x1.8	blend OIV] with Si IV
CI/CII	/4.6	[CI] from neutral shocked gas
NII/NIII	x1.4	rate N^{+2} + H too strong
NeII/NeIII	/(3 to 6)	[NeII] observation wrong
NeIV/NeIII	/2	Ne^{+3} + H and low-T diel. too strong
MgV/MgIV	x2.5	low-T dielectronic recombination
SIV/SIII	x2.1	low-T dielectronic recombination
AIII/AIV	/2.9	low-T dielectronic recombination

S. Torres-Peimbert (ed.), Planetary Nebulae, 224.

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