ON THE DETERMINATION OF PHYSICAL CONDITIONS IN THE NEBULAE

A. A. Boyarchuk, R.E. Gershberg, N.V. Godovnikov, and V.I. Pronik
(Crimean Astrophysical Observatory, U.S.S.R.)

Following the well-known physical theory of recombination and forbidden-line emission, we have carried out calculations which may be useful for a quantitative analysis of the observations of planetary nebulae and other emission objects (diffuse nebulae, emission details in extragalactic nebulae, symbiotic and flare stars). As the result, we have a set of four types of graphs.

In the first-type graphs the intensity and spectral distribution of continuous hydrogen plasma radiation (free-free, free-bound and two quanta transitions) are given for different T_e and n_e. The Balmer and Paschen discontinuities as functions of T_e and n_e are also given.

In the second-type graphs, the ratios of auroral and nebular lines of [O III], [N II], [Ne III], [Ne V], [O II] and [S II] ions are shown. These ratios are given in the plane ($\log T_e$, $\log n_e$) as curves of constant ratios and can be used for the determination of n_e and T_e by Seaton's curve-intersection method.

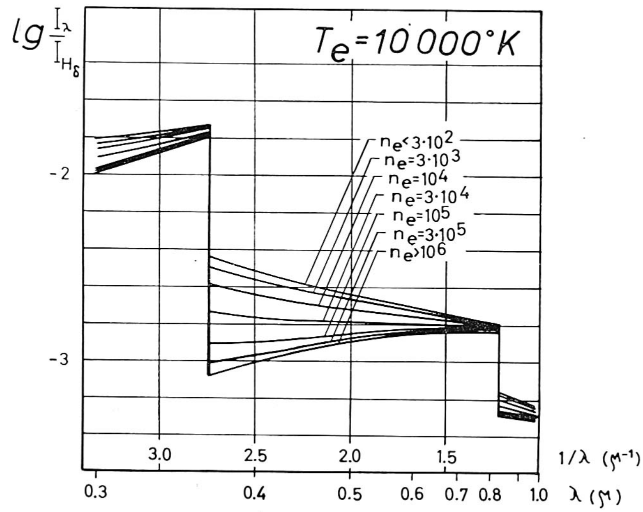

Fig. 1. *Intensity distribution in continuum at $T_e = 10000°$ as a function of n_e.*

Osterbrock and O'Dell (eds.), Planetary Nebulae, 162–165. © *I.A.U.*

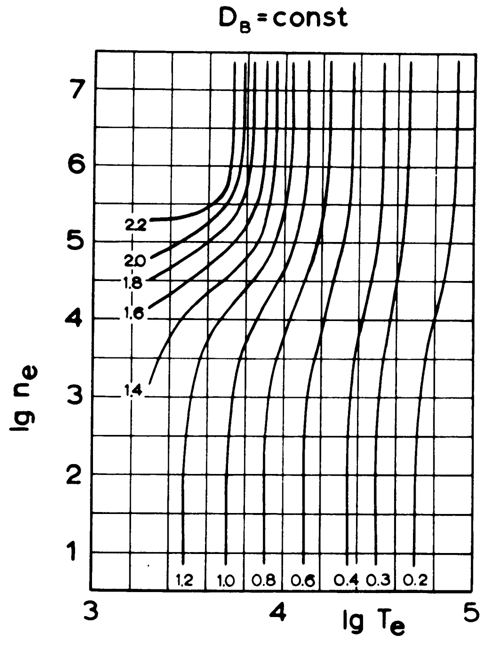

FIG. 2. *Balmer discontinuity as a function of* n_e, T_e.

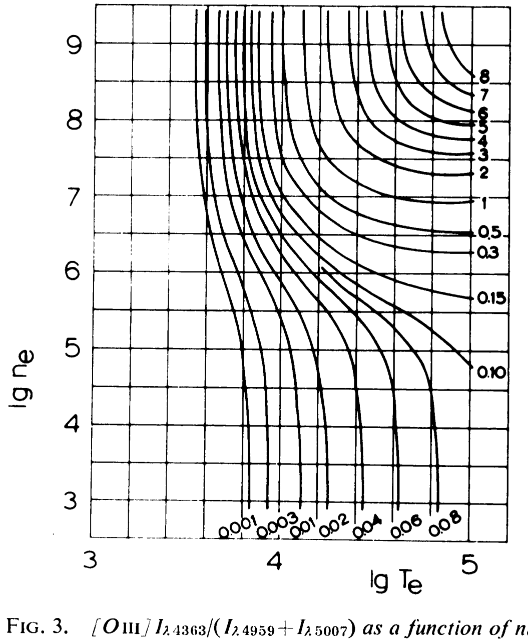

FIG. 3. *[O III]* $I_{\lambda 4363}/(I_{\lambda 4959}+I_{\lambda 5007})$ *as a function of* n_e, T_e.

https://doi.org/10.1017/S0074180900020568 Published online by Cambridge University Press

For objects optically thin in Hβ the intensity of a forbidden line is given by

$$\frac{I_i}{I_{H\beta}} = \frac{n_1}{n_p} \theta_i(n_e, T_e),$$

where I_i = intensity of forbidden line, $I_{H\beta}$ = intensity of Hβ line, n_1 = the number of ions in the ground state, n_p = the number of protons, and $\theta_i(n_e, T_e)$ = known functions of T_e and n_e.

In the third-type graphs, curves of equal values of θ_i are given in the plane ($\log T_e$, $\log n_e$) for 14 lines of [O I], [O II], [O III], [N II], [S II], [S III], [Ne III] and [Ne V].

For stationary conditions, when n_1/n_p are determined by the abundances and the Saha-Boltzmann equations for the non-equilibrium case, the ratios $I_i/I_{H\beta}$ and the intensities I_i can be determined as functions of T_e, n_e, temperature of radiation T_* and dilution factor W. These last graphs can be used to analyze some objects with secular variations of the exciting radiation and/or other physical conditions. All these graphs will be published in *Publications of Crimean Astrophysical Observatory*, **38** and **39**. All formulae used and references of atomic constants are given there.

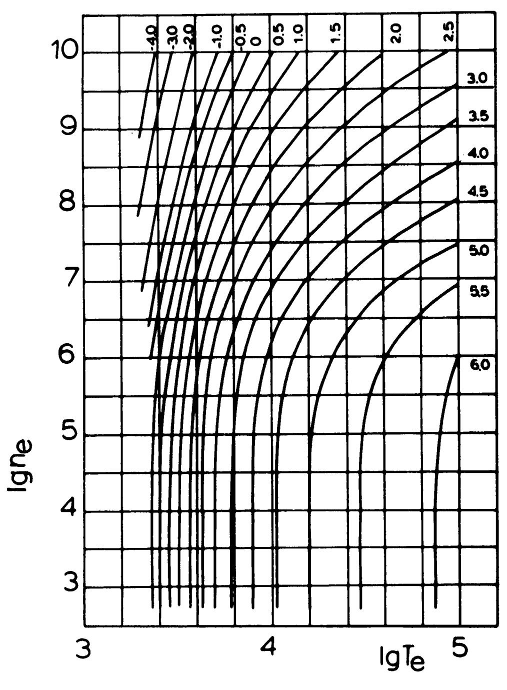

FIG. 4. *[O III] lg $\theta_{\lambda 4959+\lambda 5007}$ as a function of n_e, T_e.*

https://doi.org/10.1017/S0074180900020568 Published online by Cambridge University Press

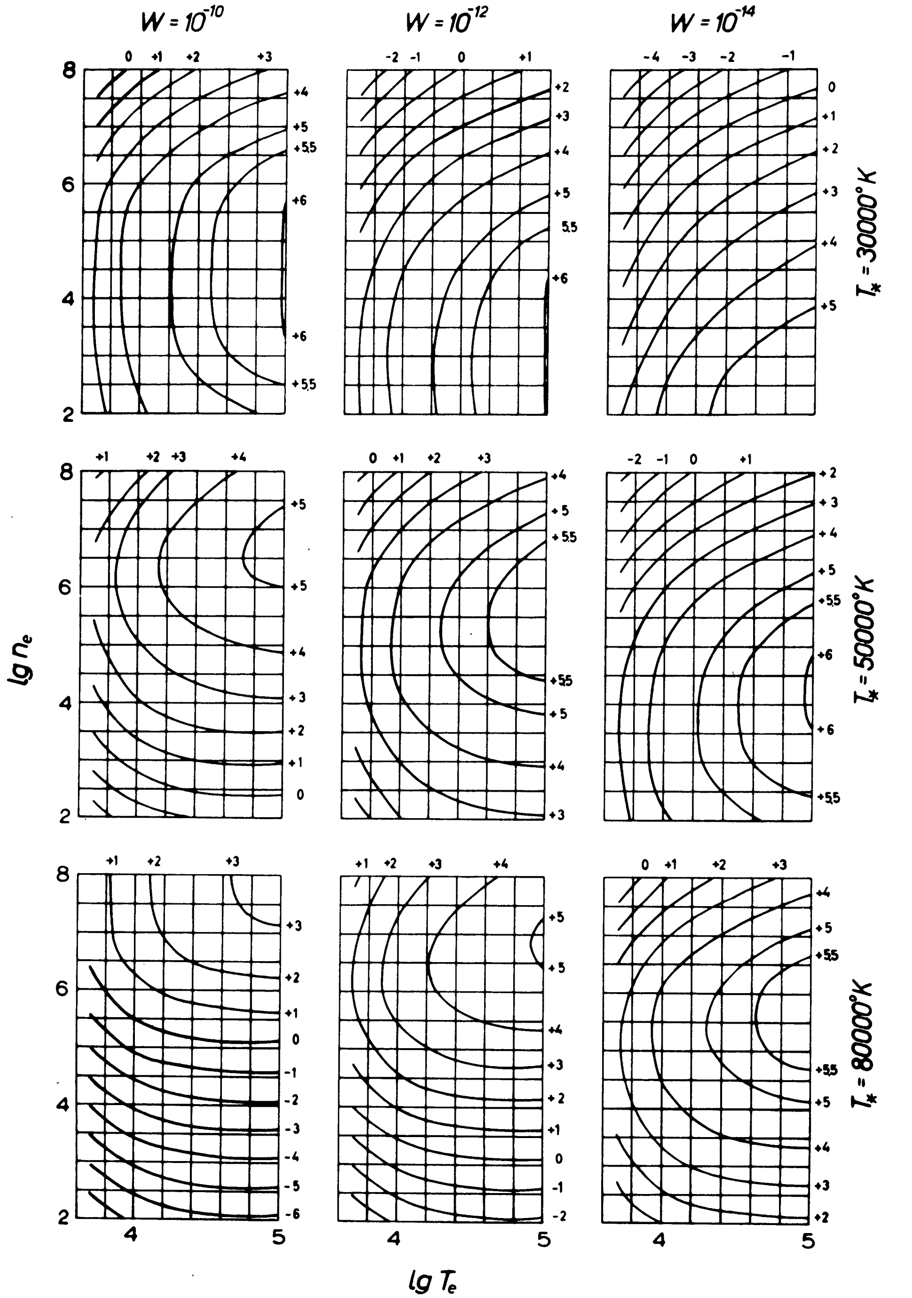

FIG. 5. *lg*$[\{(I_{\lambda 4959} + I_{\lambda 5007})/I_{H\beta}\} \times \{N(H)/N(O)\}]$ *as a function of* n_e, T_e *for various dilution factors and various stellar temperatures* T_*.