27. *On the Radiation Pressure in a Planetary Nebula. I.*

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Abstract.

The radiation pressure of the Lyman α line-radiation in a planetary nebula is discussed. Zanstra's[1] idea of redistribution in frequency in the line-contour is taken into account in detail. The equation of transfer of the Lyman α radiation with redistribution mechanism is solved in contrast with Zanstra's rough treatment in which a definite form of emission and complete redistribution are assumed. The result obtained is found to be nearly the same as in Zanstra's theory. The radiation pressure due to the Lyman α radiation is so much reduced that we should be able to get rid of the blowing-up difficulty of planetary nebula in Ambarzumian's[2] theory. Thus it is confirmed that the complete redistribution is a good approximation to the solution of this problem.

1. The fundamental equation.

The basic equation for the transfer of the Lyman α radiation in the shell of a planetary nebula is taken to be

$$\cos\theta\,\frac{d\,I(\nu,z,\theta)}{\rho\,dz} = -\,I(\nu,z,\theta)\int\sigma\left(\nu\left[1-\frac{1}{c}(vr)\right]\right)\psi(v)\,dv$$
$$+\frac{1}{4\pi}\iint dv\,dr'\,\sigma\left(\nu\left[1-\frac{1}{c}(vr)\right]\right)\psi(v)\,I\left(\nu\left[1-\frac{1}{c}(vr)\right.\right.$$
$$\left.\left.+\frac{1}{c}(vr')\right], z,\theta'\right)+Se^{-\tau}\int\sigma\left(\nu\left[1-\frac{1}{c}(vr)\right]\right)\psi(v)\,dv\,, \quad (1)$$

where z-axis is taken in the direction of direct radiation from the central star, $I(\nu,z,\theta)$ the intensity of the L_α radiation at an angle θ with the z-axis at the distance z from the inner boundary of the nebula, $\psi(v)\,dv$ is the well-known Maxwellian velocity distribution of the hydrogen atom in its ground state, σ the natural damping contour, and $Se^{-\tau}$ is assumed to be the amount of the L_α emission followed by the absorption of the Lyman continuum at the optical thickness τ:

$$S=\frac{\nu_c}{\nu}\,\frac{\kappa_c}{2\sigma_0}\,\frac{1}{4}\,S_c(1-p)\,,$$

where S_c is the intensity of the Lyman continuum at the inner boundary ν_c the frequency of Lyman limit, κ_c and σ_0 are the absorption coefficients at the Lyman limit and the line center of Doppler contour of the L_α. The first term of the right hand side in the equation (1) is due to the absorption and the second and the third

1) H. Zanstra: B. A. N., **11**, No. 401, 1, 1949.

2) V. A. Ambarzumian: M. N., **93**, 50, 1932. Y. Hagihara: Jap. J. Astr. Geophys., **15**, 1, 1938; **20**, 113, 1943. Hagihara & Hatanaka: *ibid.*, **19**, 135, 1942.