de los valores β a anularse. Con tan interesante resultado, es una lástima que apenas el 60% de todas las variables existentes en ω Cen pudo ser tratado con éxito en lo que se refiere a la determinación de sus períodos y sus variaciones. Es lamentable porque el material de placas con las observaciones necesarias existe en los archivos del Observatorio de Harvard. Son las placas tomadas por Bailey en 1891-99, pero hasta hoy en día no han sido estimadas las magnitudes de las variables No 133-169 y algunas nuevas más, últimamente descubiertas.

ON THE RED-SHIFT OF QUASARS

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In a recent note,[1] the idea was proposed that red-shift excess observed in quasars, could be interpreted as due to direct Compon effect caused by relativistic electrons. The purpose of the present paper is to give a physical basis justifing that, for which the Compton reddening formula and the cross-section of the process is nedded.

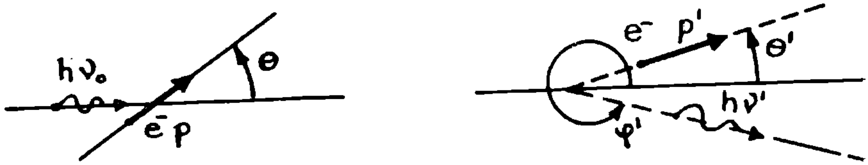
In order to derive first the Compton effect for moving electrons and secondly to study the effectivity of the process, we use the relativistic conservation equations (Section I) describing an elastic collision of a photon with a moving electron, then (Section II) the results from quantum electrodynamic for the cross section, finally a model is proposed in Section III.

I. The Compton effect

In a laboratory reference frame, the energy and momentum conservation equations are,

$$(1)\quad \begin{cases} a & h\nu_0 + E = h\nu' + E' \\ b & \dfrac{h\nu_0}{c} + p_0 \cos\theta = \dfrac{h\nu'}{c}\cos\varphi' + p'\cos\theta' \\ c & p_0 \operatorname{sen}\theta = \dfrac{h\nu'}{c}\operatorname{sen}\varphi' + p'\operatorname{sen}\theta \end{cases} \qquad E = m_0c^2\left[\frac{1}{(1-\beta^2)^{1/2}} - 1\right] \quad \beta = \frac{v}{c}$$

where h is Planck's constant, c the velocity of light, m the electron mass, v the velocity of the electron, ν the frequency of the photon, p momentum of the electron; the angles are defined in fig. 1. Primes refer to the magnitudes after collision.



before collision after collision

Fig.1

From (1), b) and c), we obtain $(p')^2$, then using the momentum -energy relation,

$$E = (m_o^2 c^4 + p^2 c^2)^{\frac{1}{2}} - m_o c^2$$

In equation (1), a), we derive,

$$\frac{\lambda' - \lambda_o}{\lambda_o} = \frac{(h\nu_o + P_o c \cos \theta)(1 - \cos \varphi') - P_o c \operatorname{sen} \varphi' \operatorname{sen} \theta}{(m_o^2 c^4 + P_o^2 c^2)^{\frac{1}{2}} - P_o c \cos \theta} \qquad (2)$$

$$\lambda' = \frac{c}{\nu'} \qquad \lambda = \frac{c}{\nu}$$

Eq. (2), gives the wavelength for the scattered photon (λ') in a φ'angle, when an original photon (λ_o) collides with an electron in the inicial conditions $p = p_o$, and forming a θ angle with the original photon direction.

In this paper we shall discuss only two particular cases from general equation (2).

a) When the electron is at rest, p = O, eq. (2) es reduced to,

$$\lambda' - \lambda_o = \frac{h}{m_o c}(1 - \cos \varphi') \qquad (2')$$

which is just the well known classical Compton effect.

b) When $\theta = 0$, $\cos \theta = 1$, (fig.2), using $\frac{m_o c^2}{(1-\beta^2)^{\frac{1}{2}}} = (m_o^2 c^4 + p^2 c^2)^{\frac{1}{2}}$ equation (2) becomes,

$$\frac{\lambda' - \lambda_o}{\lambda_o} = \frac{h\nu_o + m_o c^2 \frac{\beta}{(1-\beta^2)^{\frac{1}{2}}}}{\frac{m_o c^2}{(1-\beta^2)^{\frac{1}{2}}}(1-\beta)}(1 - \cos \varphi') \qquad (3)$$

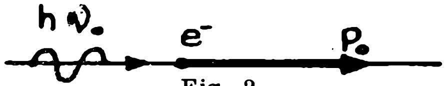


Fig. 2

For our purpose we may use eq. (3), however, if we are interested in collisions whose energy photon is in the optical wavelength, we have then,

$$h\nu_o \ll m_o c^2 \frac{\beta}{(1-\beta^2)^{\frac{1}{2}}}$$

because the order of $h\nu_o$ is of a few electron-volts, but $m_o c^2 \frac{\beta}{(1-\beta^2)^{\frac{1}{2}}} \simeq 10^{+6}$ ev when $\beta = 0.7$ and even increases with β. Therefore, in this aproximation, from eq. (3) we obtain,

$$(4) \qquad \frac{\lambda' - \lambda_o}{\lambda_o} = \frac{\beta}{1-\beta}(1-\mu) \qquad \mu = \cos\varphi'$$

Equation (4) shows that the Compton effect is very important when radiation is scattered by relativistic electrons ($\beta \gtrsim 0.9$).

II. The cross-section for Compton Scattering.

Klein and Nishina,[2] obtained the cross-section for Compton scattering, but their formula was derived for free electrons resting in a reference frame. In the simpler case of subsection Ib, (fig.2), the problem can be easily reduced to Klein-Nishina conditions by a Lorentz transformation.

In the following we shall use the Klein-Nishina formula as derived by W. Heitler.[3]

The differential cross section for unpolarized radiation, in a reference frame attached to the moving electron is,

$$(5) \qquad d\phi = r_o^2 \, d\tau \frac{1+\cos^2\theta}{2} \frac{1}{[1+\gamma'(1-\cos\theta)]} \left\{ 1+ \frac{\gamma'^2(1-\cos\theta)^2}{(1+\cos^2\theta)[1+\gamma'(1-\cos\theta)]} \right\}$$

$$\gamma' = \frac{h\nu_o}{m_o c^2} \qquad r_o = \qquad d\Omega = \text{solid angle}$$

In such a reference system the photon has the frequency,

$$\nu_o' = \nu_o \frac{1-\beta}{(1-\beta^2)^{\frac{1}{2}}}$$

that is the Doppler relativistic effect (W. Heitler, loc.cit. P59). Then $\gamma' \simeq 10^{-6}$ when $\beta = 0$, or les for relativistic electrons, so that eq. (5) becomes,

$$(6) \qquad \begin{aligned} d\phi &= r_o^2 \, d\Omega \frac{1+\cos^2\theta}{2} \qquad d\Omega = \text{sen}\,\theta\, d\theta\, d\varphi \\ d\phi &= -\pi r_o^2 (1+U^2) dU \qquad U = \cos\theta \end{aligned}$$

If we have monoenergetic electrons travelling in the same direction, the probability to scatter a photon can be computed in a reference frame attached to them. Let us assume N_e is the electronic density, then the probability to disperse a photon after going through L cm. is,

$$(7) \qquad dP = -N_e \bar{L} \pi r_o^2 (1+U^2)\, dU$$

The total probability of scattering in any direction,

$$(8) \qquad P = \int_{-1}^{1} dP = N_e \bar{L} \pi r_o^2 \frac{8}{3} = N_e \bar{L} \Phi_o \qquad \Phi_o = 6{,}653 \cdot 10^{-25} cm^2$$

By eq. (8), scattering is effectively assured if we have P = 1. Computing that, we obtain the results of Table I, first and second columns.

TABLE I

N_e (cm^{-3})	L(in pc)	L(in pc)
10^4	54.2	1.60
10^5	5.4	15
10^6	0.5	1.5

However, the situation $N_e \bar{L} \Phi_o > 1$ is possible, which means physically that a photon will collide more that once, in other words, the photon when leaving the electrons after collisions is at least scattered a θ minimun angle. Expressing that mathematically we obtain,

$$(8) \qquad \int_{\theta_m}^{-1} dP = -N_e \bar{L}\, \pi r_o^2 \int_{U(\theta_m)}^{-1} (1+U^2)\, dU = 1$$

$$\Phi_o N_e \bar{L}\; x = 1 \qquad x = \frac{3\,U_m + U_m^3 + 4}{8}$$

The third column of table I, has been computed with U (θmin) from sect. III.

The N_e and L quantities are refered to a particular Lorentz reference frame, but is easily proved that the product appearing in eqs. (7), (8) and (8') is an invariant under Lorentz transformation.

Finally we express the probability (7) in terms of angles u as measured in the laboratory system,

$$(9) \qquad dP = -N_e \bar{L}\, \pi r_o^2 \; \frac{[(1-\beta\mu)^2 + (1-\beta)^2]}{(1-\beta\mu)^4}\,(1-\beta^2)\, d\mu$$

Taking into account $U = \dfrac{\mu - \beta}{1-\beta\mu}$, W.Heitler, loc.cit.p.59.

III. A red-shift model

Assuming a quasar to be a punctual source emitting thermal radiation, and high energy electrons radially streaming from it, we can compute how the spectrum is affected on the basis given in I and II sections. We have to admit also that electrons are only slightly affected by radiation. For example, the increasing energy of the electrons after collisions, can be lost by magnetobremstrahlung radiation; the deviations of the "recoil" electrons, which as we shall show, are very small. On the other hand we can suppose that sucessive deviations, as shown in fig. 3, are maintaining about the same direction.

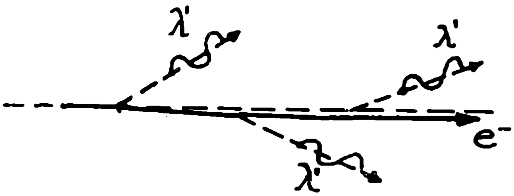


Fig. 3

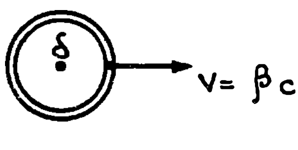


Fig. 4

Then, an electronic shell of N_e density and L cm thick as in fig.4, would be surrounding a quasar. Let f (λ) be the bosons distribution characterising the spectrum of the source, f'(λ') the new distribution when radiation has left the shell. From (4) and (9) eqs., we know the probability of a $\lambda \rightarrow \lambda'$ transition Then the observed spectrum will be related to the original by,

$$f'(\lambda') = \int f(\lambda)\, dP = \int f\left[\frac{\lambda'}{1 + \frac{\beta}{1-\beta}(1-\mu)}\right] dP(\mu) \tag{10}$$

The integral in transformation (10) must be carried out to all possible scattering angles. The kernel of this integral equation,

$$K = \frac{\left[(1-\beta\mu)^2 + (1-\beta)^2\right]}{(1-\beta\mu)^4}\,(1-\beta^2) \tag{11}$$

is mapped in fig.5showing that small deviations are the most probable ones.

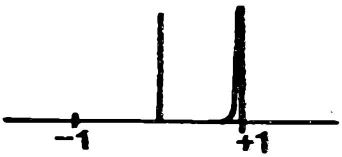


fig.5

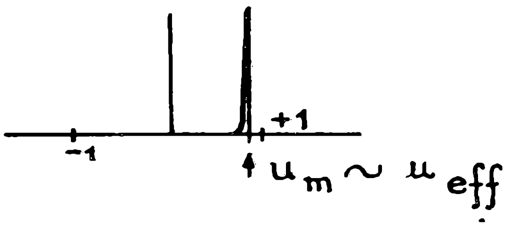


Fig.5'

Therefore, taking into account (8'), eq.(11) will be defined only between u (minimun) and -1 (see fig.5'). So that, from eq. (10),

$$f'(\lambda') = f\left[\frac{\lambda'}{1 + \frac{\beta}{1-\beta}(1-\mu_{eff})}\right] \tag{12}$$

Eq.(12), means that the observed spectrum f' (λ'), is of the same appearance as the original f(λ), but shifted to the red wavelengths by

$$z = \frac{\lambda' - \lambda}{\lambda} = \frac{\beta}{1-\beta}(1 - \mu_{eff})$$

A model which gives z = 2 was computed. For 10 Mev electrons, $\beta = 0.9988$ and $u_m = 0.9975$. The third column of Table I shows the results N_e and L obtained with (8') and X from the model.

Conclusions

The tentative model proposed in section III, can be improved or replace by another, however, the results of sect. I, showing that Compton collisions with relativistic electrons can cause large reddening effect, and sect.II giving the cross-section, are sufficient to show that such processes are really possible. In fact, an elementary dimentional analysis, namely, $\Phi_o = (N\,L)^{-1}$, gives the same results as eq. (8), which as Table I shows, are consistent with those currently accepted.[4] Then, for eq. (10) an appropiate "averaging" function must be obtained from a model (eq. II in ours), giving the red-shift coefficient,

$$z = \frac{\lambda' - \lambda}{\lambda} = \frac{\beta}{1-\beta}\left(1 - \mu_e\, ff\right).$$

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EL PROBLEMA DE LA DETERMINACION DE LAS MASAS EN SISTEMAS ALGOL.

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Uno de los métodos utilizados para determinar la masa de la componente más débil en sistemas Algol se basa en la suposición de que dicha componente llena exactamente el lóbulo correspondiente de la primera superíicie equipotencial crítica. Se muestra numéricamente, por ejemplo, que a una variación del radio de la estrella en un 10% corresponde una variación en la masa de la estrella primaria del orden del 90% y en la masa de la estrella secundaria una variación del orden del 50%.

La variación en la masa de la componente secundaria resulta directamente proporcional a la variación en el radio de la componente secundaria. Por consiguiente, el método no es adecuado y puede dar lugar a conclusiones muy erradas respecto al sistema.

One of the methods that are used to determine the mass of the fainter component in Algol systems is based on the assumption that such a component exactly fills the corresponding lobe of the first critical equipotential surface.