La largeur des raies de Balmer semble décroître tout au long de la série. La valeur moyenne conduit à une vitesse d'expansion de 3000 km/sec environ. C'est aussi la valeur mesurée pour Hβ et qui nous semble la plus sûre, car Hα, superposée à la bande A, est peut-être mélangée à [N II] et Hγ, Hδ, Hϵ sont déjà bien faibles. Ces largeurs n'ont rien d'inhabituel et peuvent se rencontrer dans les novae ou les étoiles de Wolf-Rayet. Elles ne traduiraient pas une explosion exceptionnelle. Par contre, le décrément de Balmer est très vertical. J. G. Baker et D. H. Menzel (3) trouvent pour $T_e = 160000°$

$$I(\text{H}\alpha) = 2{\cdot}93 \qquad I(\text{H}\beta) = 1 \qquad I(\text{H}\gamma) = 0{\cdot}47$$

On observe ici:

$$I(\text{H}\alpha) = 4{\cdot}9 \qquad I(\text{H}\beta) = 1 \qquad I(\text{H}\gamma) = 0{\cdot}16$$

ce qui semble bien traduire la valeur très élevée de la température électronique, en rapport avec la titanesque explosion que laisse prévoir le calcul de l'énergie libérée.

Sur les clichés, le spectre continu est bien mesurable; il a été rapporté à des étoiles de comparaison de températures de couleur connues: S Mon pour le spectre rouge, ρ Leo pour le spectre bleu. Les mesures ont été finalement toutes ramenées à l'étoile S Mon dont le ϕ_b est 0·73 et la température de couleur 28 000°. En portant en fonction du nombre d'onde $n = 1/\lambda$, log $(I_{3C\,273}/I_{S\,Mon})$, on construit une courbe expérimentale qui représente bien la répartition énergétique en $\nu^{+0{\cdot}28}$ observée par J. B. Oke (1), rapportée naturellement au corps noir à 28 000°. On constate que l'accord est très bon. Nos conclusions sur ce point sont donc les mêmes que celles de cet auteur, confirmées d'ailleurs par l'étude en 6 couleurs de H. L. Johnson (4). Toutefois, il convient de ne pas omettre, dans toute interprétation théorique, que le rayonnement observé à la longueur d'onde λ a été émis par l'objet à une longueur d'onde plus courte $\lambda_0 = \lambda/1{\cdot}16$. La précision de ces mesures spectrophotométriques diminue dans la partie la plus violette du spectre qui est sous-exposée. L'étude est alors prolongée par les mesures précises du spectre continu ultraviolet que nous avons entreprises en collaboration avec D. Chalonge et Mlle L. Divan (5). Les spectres obtenus avec le spectrographe à châssis oscillant de D. Chalonge s'étendent jusqu'à 3200 Å. Ils montrent en particulier avec une assez forte intensité l'émission du doublet de Mg II 2796–2803 Å observée à 3247–3262 Å. Le décalage $\Delta\lambda/\lambda$ est égal à 0·161.

REFERENCES

1. Oke, J. B. *Nature*, **197**, 1040, 1963.
2. Schmidt, M. *Nature*, **197**, 1040, 1963.
3. Baker, J. G., Menzel, D. H. *Astrophys. J.*, **88**, 52, 1938.
4. Johnson, H. L. *Astrophys. J.*, **139**, 1022, 1964.
5. Chalonge, D., Divan, L., Andrillat, H., Andrillat, Y. *J. Observateurs*, **47**, 93, 1964.

4. THE OPTICAL SPECTRUM OF 3C 273

J. B. Oke

The photo-electric spectrum scanners at Mount Wilson and Palomar Observatories have been used to measure the absolute flux in the spectrum of 3C 273. Observations cover the wavelength region from λ 3300 to λ 10 800; absolute emission-line strengths have also been measured. To the red of laboratory wavelength λ 5500 there is an excess of radiation which should probably be associated with the observed radio-frequency synchrotron emission. The remainder of the radiation in the red, all the blue continuum, and the hydrogen emission lines can be

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accounted for completely in terms of a hydrogen nebula with an electron temperature of 160 000°K. A second possible interpretation is that this radiation is due to a hydrogen nebula at a temperature of 14 000°K; in this case it is necessary to arbitrarily add a flat continuum of unknown origin, which must account for 93 per cent of the continuous radiation. The observed light fluctuations require, in both models, that the size of the object be a few parsecs or less and the mass of the order of $10^7 M_\odot$. At the density implied by such a model electron scattering becomes sufficiently important that light variations are difficult to explain.

(A full account has been published in the *Astrophysical Journal*, **141**, 6, 1965).

5. LIGHT VARIATIONS OF QUASI-STELLAR SOURCES

H. J. Smith

Photo-electric work by Sandage (**1**) has shown distinct optical variability of several tenths of magnitude, at least over time scales of months in 3C 48, 3C 196, and (supported by McDonald observations) in 3C 273 as well. But we lack long enough photo-electric histories of variation to see what patterns, if any, may exist. Fortunately, a great many historical photographs in various collections permit reasonably accurate tracing of the history of 3C 273 from 1886 to the present. Some details of such an analysis will appear shortly (Smith (**2**)); accordingly, the present note is a brief abstract only.

Fig. 1 is a mean light curve based on over 2000 unweighted magnitudes determined by some ten workers at various observatories, but mainly by D. Hoffleit and the author from Harvard plates, with major collections of additional points prior to 1930 from E. Geyer at Heidelberg and after 1950 from H. Huth at Sonneberg. About 500 of these same plates have also been measured by iris photometry, giving a less detailed but more accurate curve (Fig. 2). Variations have a total amplitude of about 0·7 magnitude, with apparent flash points reaching more than half a magnitude brighter yet. While some of the variation is of an apparently rather chaotic character, after 1929 a sudden sharp drop of half a magnitude seems to lead into a strongly marked quasi-periodic variation with period more than a decade.

The fact and general nature of the light variation constitute the only essential feature of this paper. But in trying to visualize an object which could produce such fluctuations, I have speculated as to whether the light curve could also be read as originating in part from damped oscillations of a very massive starlike body. On this picture most of the optical emission lines and radio emissions would presumably arise in successively more extended outer regions, not necessarily directly relevant to variations at the hypothetical 'photosphere' of such an object.

In particular, at the Dallas Symposium on Gravitational Collapse I had remarked that three points might be noted as consistent with the presence of a central body having very rough order-of-magnitude dimensions and mass of 2×10^{16} cm and $10^6 M_\odot$ respectively. First, the apparent flash so far found to have shortest duration, and supported by several consistent iris photometer observations, is a 1929 event indicating a 10-day rise of 0·7 magnitude and a total duration of 4 weeks. If this event is real, light travel time sets an upper limit of less than 10^{17} cm for the size of the region undergoing the brightening. Secondly, if this region is associated with the core of the object, and if a significant share of the continuum originates from an effective photosphere of temperature in a range generally commensurate with the color indices, then a surface again a few times 10^{16} cm is required to produce the large absolute magnitude of 3C 273. Finally, a mass of some $10^6 M_\odot$ within such a radius would, by application of the simple