LETTERS TO THE EDITORS

ASTROPHYSICS

Oscillation Broadening of Lines from Ionized Elements in Stellar Spectra

THE well-known sources of line-broadening in stellar spectra may be summarized in two main groups. (1) Broadening resulting from the finite length of the wave-trains emitted by the atoms. The length is determined by (*a*) the finite life-time of the excited level, that is, radiation damping, and by (*b*) abrupt phase-changes in the emitted wave caused by perturbations of the emitting atoms by other particles, that is, collision damping and Stark effect. (2) Broadening resulting from Doppler effect of different types. The Doppler velocities may be of a random character, for example, thermal or turbulent motions of emitting atoms, resulting in a line profile of gaussian shape, or the broadening may result from the integration of contributions to the line from different parts of a rotating star, an expanding gas shell or a pulsating star. In addition, broadening or splitting of lines by magnetic fields (Zeeman effect) and by coupling between the nuclear spin and the angular momentum of the electrons of the emitting atom (hyperfine structure) can occur.

The aim of this communication is to direct attention to a broadening mechanism which has not been mentioned in the literature.

Abrupt disturbances introduced in a plasma will give rise to electron oscillations at, or near, the Langmuir frequency. To a first approximation, the electrons will perform harmonic, linear oscillations about a position of equilibrium, with a linear velocity $V_e = V_{oe} \cos \omega_p t$, where $\omega_p \sim$ Langmuir frequency, the restoring force being the field set up by the electrons themselves.

It will be shown in a subsequent paper (in preparation) that ions in the field set up by the electrons will oscillate with the same frequency as the electrons and with a maximum velocity :

$$V_{oi} = \frac{Z.2}{A.1{,}840} \cdot V_{oe}$$

where Z is charge of ion in units of electronic charge and A is mass of ion relative to the mass of the hydrogen atom.

This means, if the state of excitation of the oscillating ions is such that they give rise to an absorption or emission line, the observed line will, in addition to the width determined by the well-known sources mentioned above, show a broadening caused by Doppler velocities of the form $V = V_{oi} \sin \omega_p t$.

This broadening effect is proportional (1) to the oscillatory velocity of the electrons (or, to the magnitude of the oscillations) and (2) to the charge to mass ratio of the ions in question.

The line profile may be determined qualitatively by treating the phenomenon as a frequency modulated signal at a rest-frequency $\omega_o = 2\pi c/\lambda_o$ with a modulation frequency ω_p (the Langmuir frequency) and a modulation index $\beta = \frac{V_{oi}.\omega_o}{c.\omega_p}$, resulting in a line pattern consisting of frequency components centred at $\omega_o \pm n.\omega_p$, where $n = 0, 1, 2, 3. \ldots$

The amplitude of the nth component is given by the Bessel function of the first kind and nth order with β as argument. In addition, each component of the line pattern is subject to conventional broadening.

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Deflexion of Light in the Gravitational Field of the Sun

ACCORDING to the whirl theory of light and matter[1], the whole physical world is the manifestation of Maxwell's electromagnetic waves. The fundamental particles of matter, and the photons, are represented by integral solutions of Maxwell's equations *in vacuo*, in cylindrical co-ordinates. For the former the integral is taken from a very low limit of the variable parameter of the integrant solution to infinity, while in the latter the interval of integration is much smaller. The forces are determined from the standard equations of classical dynamics as the derivatives of the exchange integrals of electromagnetic fields of interacting entities with respect to parameters defining their mutual position. The necessary condition of physical validity of these forces is the synchronism between the fundamental frequencies of the entities or their sub-harmonics. In the case of gravitation the sub-harmonics are due to the 'micro-precessions' of the entities, of about $8 \cdot 3 \times 10^{-7}$ sec.$^{-1}$, caused by their inherent eccentricity of about 10^{-10} h/mc. In this very slow motion the wave-length of de Broglie's waves (which are inherent in these solutions of Maxwell's equations) is about 10^{12} cm. They are called the 'macrowaves'. The macrowaves produce the mutual synchronization of micro-precessions. The resultant macrowaves of thus synchronized particles constituting large axially symmetrical bodies, such as the Sun or the planets, form co-axially revolving wave systems with radial standing waves. The orbits of planets are situated in the troughs of the latter.

The whirl theory has permitted, so far, the calculation of fourteen physical constants from five observation data (c, h, e, the mass of the proton m_+, and the gravitational constant γ_g). These included the mass ratio of the proton and electron, the masses of the neutron and of the light nuclei $_1H^2$, $_1H^3$, $_2He^3$, and $_2He^4$, the distance from the Sun (ref. 1*k*), and the period of rotation and of sidereal motion, of Mercury, the relationship between the periods of rotation of planets and their distances from the Sun, and the magnetic moment of the Earth. The results of the calculations agreed very well with the observation data. The period of rotation of Venus (20 hr. 48 min.) which followed from these results appeared too small at that time (1950), but it was later confirmed by the radio-astronomical observations in the United States (22 hr. 16 min.) disclosed in 1956 [2]. The whirl theory also permitted an explanation on the basis of Max-