Origin of Sporadic Meteors.

Gentlemen,—

Proceeding from the supposition that the repulsing forces of the Sun in comet tails of type II. and III. (according to Bredikhin) are due to the radiation pressure of the Sun upon the particles of the cosmic dust, an approximate formula may be written connecting the radius r of the dust particles, its density (δ), and the quantity corresponding to the radius of the repulsive acceleration ($1+\mu$) of the Sun :

$$r(1+\mu)\delta=6{\cdot}26.10^{-5}. \quad \ldots \ldots \quad (1)$$

The quantity δ may be assigned two values : 3·5—the mean density of the stone meteorites and 7·8—the same as that of iron meteorites. Table I., of quantities $1+\mu$ and r, is computed from a more accurate formula ; the divergence from the approximate one (I.) takes place only in case of small r. In the same table is given the mass of dust particles.

Table I.

$\delta=3{\cdot}5$ gms.				$\delta=7{\cdot}8$ gms.			
$1+\mu$.		r.	m.	$1+\mu$.		r.	m.
		cm.	gms.			cm.	gms.
2·8	Type II.	8.10^{-6}	8.10^{-15}	1·3	Type II.	8.10^{-6}	2.10^{-14}
0·8	Type II.	3.10^{-5}	5.10^{-13}	0·4	Type II.	3.10^{-5}	9.10^{-13}
0·01	Type III.	$1{\cdot}8.10^{-3}$	8.10^{-8}	0·005	Type III.	$1{\cdot}8.10^{-3}$	2.10^{-7}
0·001	Type III.	$1{\cdot}8.10^{-2}$	8.10^{-5}	0·0005	Type III.	$1{\cdot}8.10^{-2}$	2.10^{-4}
0·0001	Type III.	$1{\cdot}8.10^{-1}$	8.10^{-1}	0·00005	Type III.	$1{\cdot}8.10^{-1}$	2.10^{-1}

The mass of a sporadic meteor is considered to be of the order of 0·1–0·01 gms. According to Table I. such dust particles could be found in the tails of type III. From the theory of comet forms it is known that the particles in the tails of type III. are moving along hyperbolic orbits with eccentricities close to unity ; these particles, wrenched away from the nucleus of the comet, are leaving for ever our solar system. It is very likely that comets are not only around the Sun, but also near other stars of the Milky Way ; in this case streams of these particles ought to issue from these solar systems in all directions. These particles may enter the sphere of action of the Sun, and, finally, be consumed as a meteor in the Earth's atmosphere.

The velocity of a particle with regard to the Sun may be calculated at any point of the path. Let S be the Sun: S′ one of the stars at the distance $a = SS'$ from the Sun: A, the particle, moving along the straight line from star to the Sun, $AS = x$. Let us assume that the star S′ has a mass m times greater than the Sun's mass and an absolute brightness n times greater than the Sun's. Then in explaining the repulsion by radiation pressure we shall have for the repulsive acceleration of the star S′ the following expression

$$m + M = n(1 + \mu), \qquad (2)$$

where M is the effective acceleration of the star, and μ the effective acceleration of the Sun upon the same particles (the resultant of the accelerations of attraction and of repulsion of the star or the Sun is called the effective acceleration).

Let the particle A, having left the nucleus of the comet, and moving along a parabola around the star S′ with a zero velocity relative to the comet, or a parabolic velocity v_0 with regard to the star S′,

$$v_0 = K\sqrt{\frac{2m}{a - x_0}}. \qquad (3)$$

The acceleration of particles A relative to the Sun at a distance x will evidently be

$$\frac{d^2x}{dt^2} = \frac{K^2\mu}{x^2} - \frac{K^2M}{(a-x)^2}. \qquad (4)$$

This equation may be written in the form

$$v\frac{dv}{dx} = \frac{K^2\mu}{x^2} - \frac{K^2M}{(a-x)^2}, \qquad (5)$$

after integrating we get

$$v^2 = -\frac{2K^2\mu}{x} - \frac{2K^2M}{a-x} + C, \qquad (6)$$

where C is determined from the initial conditions of motion (3) taking $a - x_0 = 1$.

The equation (6) allows us to calculate the velocity for any point of the path, and consequently to determine the time of the flight of the particles from the star to the

Sun. Putting zero as the derivative of equation (6) by x, we get the distance x_m from the Sun, where the velocity will be least; at the same point the resultant of the acceleration is equal to zero,

$$x_m = \frac{a\sqrt{\mu}}{\sqrt{M}+\sqrt{\mu}}. \quad \quad (7)$$

As an example, we will take a star with the following parameters: $m=3$, $n=30$, $a=600{,}000$ units. The repulsive acceleration for the particles discussed is of the order of 10^{-4} or $1+\mu=0{\cdot}0001$; hence the effective acceleration of the Sun may be assumed equal to -1, and according to formula (2) $M=-3$ (with an accuracy to the third decimal). From formula (6) we will calculate the velocity for 10 points of the path; the results are listed in Table II.

TABLE II.

x.	v.
599,999	72·9 km./sec.
500,000	0·232
400,000	0·167
300,000	0.144
x_m=219,000	0·138
200,000	0·138
100,000	0·159
10,000	0·428
1,000	1·333
1	42·09

Knowing the velocities at any point of the path, we can by a mechanical quadrature find the time during which the particle will fly from the star S′ to the Earth orbit ($x=1$). This time is of the order of 8,000,000 years. As anticipated, the velocity of the particles at a distance of 1 (Earth orbit) with regard to the Sun proved to be nearly parabolic ($v=42{\cdot}1$ km./sec.).

If the star has a radial velocity with regard to the Sun, then, should the velocity be positive (the star is receding from the Sun) and more than $v_n=0{\cdot}138$ km./sec. the particle would not reach the sphere of the Sun's action; hence we see that the particles at the distance of the Earth's orbit cannot have velocities smaller than parabolic ones. Given positive radial velocities smaller or equal to v_m—the velocity at the Earth's orbit will practically not differ from parabolic ones; in case of negative radial velocities v^* the final velocities v of the particles will be hyperbolic ones; their values may be easily computed (Table III.). Consequently, on the average, the velocities of sporadic meteors ought to be hyperbolic, which indeed may be observed.

Table III.

v^*.	v.
0 km./sec.	42·1 km./sec.
− 10	43·3
− 20	46·7
− 60	73·4
−100	108·6

Conclusion.

The assumption that the sporadic meteors are originating from comets of other solar systems alien to our own is not inconsistent with the data available.

I am, Gentlemen,
Yours faithfully,
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OBITUARY.

F. A. Bellamy.

Frank Arthur Bellamy, who died suddenly in February of the present year, was born at Oxford on the 17th October, 1863; he was the youngest of a family of six. From a private school he went on to Magdalen College School, and from thence he entered the Radcliffe Observatory at a comparatively early age. In that step he had been preceded by two of his brothers, but he alone was destined to devote a long life to the service of Astronomy. It was spent entirely in his native city. Even the holidays he enjoyed were few and short.

In the 'eighties, when Bellamy was serving his apprenticeship, the Radcliffe Observatory under E. J. Stone was occupied in meridian work with the addition of routine meteorology. Early in the next decade a vacancy occurred at the University Observatory, and by accepting it Bellamy found the opportunity to undertake a different