assigned to these types, and it is clear that if Russell's densities are correct the sixth-root law must be close to the truth.

If a is the radius of a star the total radiation will be proportional to a^2T^4, which varies as ga^2, *i.e.* as M. The total radiation thus depends only on the mass, and not on the density or stage of evolution. The absolute luminosity is a fairly good measure of the total radiation for the range of temperature here considered, though, of course, the visibility of the radiation changes a little with the temperature. We shall thus have the total radiation constant as we pass through the series of spectral types, and the luminosity roughly constant (with deviations amounting to about $1\frac{1}{2}$ magnitudes). This is just the feature which Russell has pointed out in the luminosities of the giant stars; they are practically the same whatever the type of spectrum.[4]

It may be remarked that this theory avoids a difficulty noticed by J. Perry[5], that when γ is less than $\frac{4}{3}$, the heat within the contracting star is greater than the energy set free by contraction, leaving less than nothing for radiation into space; the difficulty is even more serious than Perry considered, for he did not make any allowance for the enormous store of ethereal energy necessary for equilibrium with matter at high temperatures. But we have seen that by taking account of radiation-pressure the interior temperature is much reduced; less internal heat is therefore needed; and there is, in fact, an ample balance of energy left for dissipation even when γ is considerably below $\frac{4}{3}$.

With a molecular weight smaller than 54 the importance of radiation-pressure is reduced; for example, with molecular weight 18 radiation-pressure is 6/7 of gravity, instead of 19/20. But it still plays a predominant part until we come down to molecular weight 2. Reasons have been urged in favour of a low average molecular weight—perhaps as low as 2. It is probable that the atoms are highly ionised by the radiation of short wave-length within the star; and if most of the electrons outside the nucleus are split off from each atom we shall actually have an average weight for the ultimate independent particles nearly equal to 2, whatever the material (excluding hydrogen). Radiation-pressure is then less than half gravity; but the two principal laws, which seem to be verified by observation, are arrived at as before. Moreover, the order of magnitude of k is scarcely altered; it is now 5 instead of 30 C.G.S. units. Nor is the internal temperature much changed. In fact, the effect of ionising the atoms is that the pressure of the superincumbent layers is supported by a mixture of cathode rays and X-rays, instead of by X-rays alone; our doubt as to the proportions in which these occur and as to which will predominate is no serious hindrance, because the main results are nearly the same in any case.

A. S. EDDINGTON.

[4] *Loc. cit.*, p. 252, Figs. 1, 2, and 3.
[5] NATURE, vol. lx., p. 350.

DR. W. H. BESANT, F.R.S.

THE death of William Henry Besant on June 2, in his eighty-ninth year, will be mourned, in all sincerity, by a far greater number than he would have anticipated, supposing that he ever wasted a thought on the subject. Among these will be a legion of his old pupils, who had the opportunity of learning to know him in a peculiarly intimate way. Until 1880 or so Besant and Routh had almost a monopoly, for many years, in coaching pupils for the Mathematical Tripos. Besant's method was rather odd, but very effective with the right sort of man. At the cost of immense labour he had written out, with his own hand, a set of "bookwork and rider" papers covering the whole range of the examination. The pupil, on each of his three weekly visits, found one of these papers awaiting him in the outside room, and proceeded to answer it as well as he could on the backs of old examination scripts. If he had not brought a pen of his own, he had to search among a lot of ancient quills until he could find one that was not hopelessly spoiled. Presently, Mr. X would be politely summoned to an inner parlour, where his last exercise would be returned to him corrected and annotated, and if he had failed to answer any question he would be either shown a solution or given a hint how to proceed.

Of course, it was not every pupil that was taken separately like this; some of them were taken in small batches (not exceeding five or six), but the general method was the same. It should be added that once every week each pupil took away with him a printed problem paper to be done at leisure in his own rooms. The results were marked, and the list was available for inspection.

As a member of St. John's College staff Besant used to give "lectures" of a sort; but (unlike Routh) he eschewed formal lectures on bookwork. His solutions of problems were always original and elegant, and he had the great advantage (for a coach) of being equally good in geometry, analysis, and dynamics.

Besides being one of the *par nobile fratrum* of coaches, Besant was a busy and trusted examiner, and in this connection it may be recorded that he used to say that ten minutes of oral examination were worth any amount of written *ditto*.

Besant was too much engrossed by his proper work to add much to mathematical literature. His text-books on conics, dynamics, hydrostatics, and hydrodynamics deserved their popularity, and are still worth consulting, though their point of view is now rather antiquated. His one thoroughly original printed work, the tract on roulettes and glissettes (first edition, 1869; second edition, enlarged, 1890), shows all his qualifications at their best. Besant had really studied Newton, and had an exceptional power of estimating different orders of infinitesimals from a figure. His invention of the term

"glissette" is a reminder to those who knew him that he preferred the works of the great French mathematicians to all others, and would rather read a good text-book in French than one in English.

It used to be a commonplace among Cambridge undergraduates that Besant was the handsomest Senior Wrangler that ever was. Anyhow, he was a very handsome man; so far as his head and face were concerned, he resembled the photographs of Russell Lowell. The left eye and eyebrow were damaged by a mountaineering accident. Above all, his manners were perfect—or as near perfection as human manners can be (curiously enough, his gyp Scott, when I knew them both, was the most gentlemanly gyp in college); no one who had much to do with Besant could help trying to be polite.

Besant was Senior in 1850 (four years before Routh), F.R.S. in 1871, and Sc.D. (Cant.) when that degree was first instituted. He and Routh were the first two to receive it, and he really enjoyed the distinction, though he used to pretend that he accepted it only to please his "womenfolk,"[1] and had to take a cab to the Senate House, lest ribald boys should jeer at his salmon and geranium gown. G. B. M.

NOTES.

WE notice with much regret the announcement of the death on June 9 of Prof. T. McKenny Hughes, F.R.S., Woodwardian professor of geology in the University of Cambridge, at eighty-five years of age.

IN the list of birthday honours last week we ought to have included the names of Lieut.-Col. A. W. Crossley, F.R.S., and Lieut.-Col. E. F. Harrison, two chemists who have received the distinction of C.M.G. in recognition of valuable services in connection with the war.

SIR WILLIAM D. NIVEN, whose death was announced in last week's NATURE, was born at Peterhead in 1842. After attending the Grammar Schoo' there, he entered King's College, Aberdeen, and graduated in 1861, obtaining the Simpson prize in mathematics. He afterwards entered the University of Cambridge, where he graduated in 1866 Elected to a fellowship in Trinity College, he for some years acted as assistant tutor. For a time he held an appointment at the Royal Military Academy, Woolwich, but he was back again in Cambridge by 1873. In 1883 he succeeded Dr. Hirst as Director of Studies at the Royal Naval College, Greenwich, a post which he held until his retirement in 1903, when he was created K.C.B., having been made C.B in 1897. He was elected a fellow of the Royal Society in 1882, and served for several years on the council of the society, and for a period of two years was vice-president. He was president of the London Mathematical Society in 1908 and 1909. Sir William was the author of numerous papers in mathematics and mathematical physics. He was virtually Clerk Maxwell's literary executor, and prepared and edited his collected works. His services as Director of Naval Education won the high regard of the Service and the attachment of the chiefs of its scientific branches. In recognition of his work, a group of scientific friends presented him with his portrait in 1911, and it is preserved in the collection of the University of Aberdeen.

[1] Perhaps, like the Antiquary, he said "womankind"; I forget.

THE death is announced, on June 11, at eighty-six years of age, of Sir W. C. Macdonald, the Chancellor and President of McGill University, and a generous benefactor to education and science in Canada. A list of his chief donations given in the *Times* of June 12 is here summarised. The gifts to McGill University included a fully equipped engineering building, which cost more than 70,000*l*., besides endowment; a physics building, costing 60,000*l*.; a building for the departments of chemistry, mining, and architecture, costing 100,000*l*.; 30,000*l*. to endow the faculty of law; 18,000*l*. for two chairs of physics; at least 42,000*l*. for the endowment of engineering; 10,000*l*. for a pension fund, and other endowments; also a large area of land close to McGill, and bought for 200,000*l*. for the University. To promote rural education, Sir William Macdonald established four "consolidated schools," one each in Ontario, New Brunswick, Nova Scotia, and Prince Edward Island, all equipped for manual training, household science, and nature-study in practical gardening, as well as for the more conventional subjects, spending about 36,000*l*. on this experiment; and the sequel was the establishment of the Macdonald College at St. Ann's for teachers, farmers, and farmers' wives at a cost of about 600,000*l*. When the college was complete the founder presented it to McGill, along with 400,000*l*. as endowment.

THE interim and final reports of the Halakite inquiry have been issued by H.M. Stationery Office (Cd. 8446, price 1*d*.). The general findings of Mr. Justice Shearman, with whom Prof. W. J. Pope sat as assessor, have been widely read but particular interest attaches to Prof. Pope's report. The original specification refers to an explosive having as a basis an admixture of lead nitrate with glycerine, and prescribes hydrocarbons, nitro-compounds, such as collodion or nitrobenzene, and barium and potassium chlorates and nitrates as possible constituents. It is stated that under the working conditions employed the glycerine reacts with the metallic nitrates to form a nitrocompound. Such a claim "is untrue, and the specification is the production of charlatans who seek to conceal the worthless nature of their invention by the use of a scientific terminology." The earlier samples submitted did consist largely of metallic nitrates, the proportions of which varied considerably, but the nitrocompounds were found to be short lengths of Mark I. cordite. Indeed, all samples presented to the court contained manufactured cordite as the common ingredient. Halakite was recommended by its proprietors for use as a smokeless powder for propellent purposes and as a bursting charge for shells. The report points out that explosives of such composition are so sensitive to shock that they cannot be used as high explosive for shell with any reasonable degree of safety, whilst the considerable proportion of metallic nitrates renders them unsuitable for propellent purposes because of low explosive power and dense smoke. A later sample submitted to the French Government in April, 1916, proved to consist of about 98 per cent. of Mark I. cordite, the balance being mainly lead chromate Prof. Pope says that the clumsy nature of the fraud was obvious to the British and French authorities concerned The whole case is an illustration of the stupidity of otherwise astute business men accepting statements of self-styled "inventors," and failing to avail themselves of the advice of an independent expert chemist, which action certainly would have saved large sums of money and the waste of much valuable public time, as well as avoided a depressing public inquiry.