the increase in the eccentricity of orbit would also have been largely reduced.

Notwithstanding this criticism, it appears to me that Mr. See fairly establishes the proposition that a high eccentricity is explicable by means of tidal friction.

Turning, then, to the question of the relative masses of the components of double star systems, Mr. See remarks with justice that the comparable brightness of the components renders it highly probable that the masses are also comparable, and he sees in certain results of M. Poincaré and of my own an evolutionary explanation of this fact.

Jacobi first showed than an ellipsoid of homogeneous fluid, with its three axes bearing to one another proper proportions, is a figure of equilibrium when it rotates about its smallest axis with a proper angular velocity. M. Poincaré next showed that if the length of the Jacobian ellipsoid exceeds the breadth in a certain ratio, the equilibrium becomes unstable, but that there is a stable figure which may be described as a Jacobian ellipsoid with a furrow nearly round the middle, so that it resembles an hour-glass with unequal bulbs. If we trace the further development of the hour-glass we find its neck gradually thinning, and finally rupturing the figure of equilibrium, henceforth consists of two detached masses.

My own attack on this problem was from the opposite point of view, for I endeavoured to trace the coalescence of a pair of detached masses so as to form an hour-glass or dumb-bell.

Mr. See reproduces the figures illustrative of both these investigations, and remarks that they both show that when there is a gradual detachment from a rotating figure of equilibrium, the detached portion will not normally be a ring, but that there will ensue two quasi-spheroidal masses of matter of comparable magnitude. He also remarks that if the fluid be heterogeneous, the ratio of the masses will be much smaller than when it is homogeneous.

In the discussion of these figures of equilibrium the wording of the essay appears a little careless, for it might naturally be supposed to mean that increase of angular velocity is a necessary concomitant of the rupture of the neck of the hour-glass. Now it is a somewhat paradoxical fact that, with constant density, the longer elongated figures of equilibrium rotate more slowly than the shorter ones, and it might therefore seem that the rupture of the neck should go with retardation of angular velocity. But it is the value of the square of the angular velocity divided by the density which determines the length of the elongated figures, and thus increase of density tells in the same way as retardation of angular velocity. In the history of a nebula the only condition for rupture which can be specified is that of contraction.

The probability of this view of the genesis of double stars is strikingly illustrated by a number of drawings by Sir John Herschel of various nebulæ. The great similarity between Herschel's nebulæ and the theoretical hour-glass is obvious. It may be hoped that in the book which Mr. See promises he will also illustrate this point by photographs.

Annulation is usually accepted as the mode of separation in the nebular hypothesis, but, as already stated, this is held by Mr. See to be exceptional. He thus regards the ring of Saturn as being as exceptional in its history as it now is in appearance. Where he maintains that Saturn's ring will never coalesce into a satellite, he might with advantage have referred to the remarkable investigations of M. Roche,[1] who showed that a satellite would be torn to pieces by tidal action if it revolved at a distance of less than 2·44 times the planet's radius. We may here note the interesting fact that whilst Saturn's ring almost touches "Roche's limit" on the inside, the Martian satellite, Phobus, and the fifth satellite of Jupiter[2] almost touch it on the outside.[3]

In order to prove his thesis as to the highness of the eccentricity and the comparability of masses, Mr. See gives a careful table of the observed elements of the orbits and of the relative brightnesses of seventy-three pairs of double stars. The values of the elements are of course open to much uncertainty, but the mean eccentricity, which is found to be ·45, must lie near the truth. In the few cases in which the masses have been determined, they are found to be comparable, and the comparability of the brightnesses confirms the generality of this law. Thus the facts of observation agree with our author's ideas.

Mr. See must be congratulated on having written an essay of great cosmogonical interest, and although his theory may never be susceptible of exact proof, yet there is sufficient probability of his correctness to inspire us with fresh interest in the observations of double stars.

G. H. DARWIN.

MAGNETIC INDUCTION IN IRON AND OTHER METALS.

Magnetic Induction in Iron and other Metals. By J. A. Ewing, F.R.S. (London: *Electrician* Office.)

IN this admirable book Prof. Ewing has brought together matter which was before to be found only in the journals of learned societies, and he has also given a full account of his own researches in magnetism. The book is written in a lucid style, and is supplied with numerous references to original papers.

In Chapter I. Prof. Ewing explains clearly the meaning of such terms as "intensity of magnetisation" and the like, which many students have difficulty in understanding. As stated in the preface, he has "endeavoured to familiarise the student with the notion of intensity of magnetisation (I) as well as with the notion of magnetic induction (B)." When endless magnetic circuits are discussed, it is convenient to talk of "permeability" and "induction"; on the other hand, "magnetic poles" and "magnetisation" are just as important when permanent magnets are dealt with. The magnetisation of ellipsoids and the influence of the shape and dimensions of magnetised bodies upon magnetic quality are fully treated.

[1] "Acad. des Sciences de Montpelier," vol. i. (1847–50), p. 243. See also Darwin, *Harper's Magazine*, June, 1889.

[2] The values given by Barnard (NATURE, p. 377) make the distance 112,000 miles, and Roche's limit 107,000 miles.

[3] It is proper to warn the reader that Roche's limit depends to some extent on the density of the planet. For the sun it will be about one-tenth of the earth's distance from the sun. Thus a body of planetary size cannot move in a highly eccentric orbit, so that its perihelion distance is one-tenth, without being broken up into meteorites; and conversely a flight of meteorites with less than the same perihilion distance can never coalesce into a planet.

Chapters II. and III. are devoted to measurements of magnetic quality by the magnetometer and ballistic methods. With respect to the former very full information is given as to the construction of the apparatus and its use.

The earth's coil as a means for calibrating the Ballistic Galvanometer is fully explained, as also that of a solenoid and current. Mention is not made of a convenient method of calibration in which the quantity of electricity passed is given directly by $Q = \frac{A}{a}\frac{\tau}{2\pi}$; where A is the deflection corrected for decrement; a is the steady deflection due to unit current, and τ is the periodic time of the ballistic needle. Here a and τ are quantities very readily obtained.

The chapter concludes with a full description of Dr. Hopkinson's "Bar and Yoke" method.

Chapter IV. contains valuable information with regard to curves of induction and hysteresis in the case of wrought iron, steel, and cast iron, which will be of use to the electrical engineer in the design of dynamo electric machinery. The effects of annealing and stretching iron are brought forward and well illustrated.

The next chapter, on magnetic hysteresis, is perhaps the most important in the book. It commences by giving a clear definition of hysteresis, the effects of which are amply illustrated by curves, and stress is laid upon the definition of permeability as being the ratio of B to H *with certain limitations*.

The dissipation of energy through magnetic hysteresis —which plays such an important part in the design of cores for transformers, and the armatures of dynamos—is fully treated.

The remarks on magnetic viscosity towards the end of the chapter are worthy of very careful consideration. The author points out that in the case of quick cycles, $\int H dI$ may be widely different from what is found to be the case by static methods, and further remarks that experimental evidence is wanting under this head.[1]

Chapter VI. treats of magnetism in weak fields. The author refers to experiments by Lord Rayleigh and himself, in which the time effect upon magnetism is clearly shown—the creeping up of the magnetism going on for a considerable time.

Magnetism in strong fields is discussed in Chapter VII. The "Isthmus Method" introduced by the author and Mr. W. Low in 1887 is capable of producing magnetic fields of enormous strength. In giving his conclusions from experiments by the isthmus method the author states, "there is apparently no limit to the value to which the induction may be raised. But, when we measure magnetisation by the intensity of magnetism I, we are confronted with a definite limit—a true saturation value, which is reached or closely approached by the application of a comparatively moderate magnetic force."

A full account of Dr. Hopkinson's researches on the effect of temperature on magnetism is given in Chapter VIII., and reference is made to the identification of recalescence with recovery of the magnetic state. In the latter part of the chapter hysteresis, in the relation of magnetic susceptibility to temperature, is dealt with; and mention is made of the wide range of temperature through which the alloys of iron and nickel may exist in either the magnetic or non-magnetic state.

Reference is made to the researches on recalescence of Osmond, who has since shown the marked influence of the initial temperature, and the rate of cooling on recalescence in the case of chromium steel. Dr. Bottomley has shown that the alloys of chromium and steel in the unannealed state have exceptionally high magnetic qualities, which are confirmed by experiments of Dr. Hopkinson.

In Chapter X. the magnetic circuit is discussed, and the way in which it is applied to the design of dynamo electric machines and transformers. Reference is made to the important work of Drs. J. and E. Hopkinson and Kapp upon this subject—more especially in connection with dynamo electric machinery. In pursuing the analogy of the magnetic circuit to the ordinary conduction equation, Prof. Ewing lays stress upon the fact that the permeability (μ) is a function of the induction (B), and this is a point which cannot be too strongly urged. Much that is in this chapter has great practical importance—the treatment of the subject being considered from a graphical, as well as analytical, point of view. The chapter ends with an account of the influence upon magnetism by cuttings and the compression of joints in magnetic circuits.

The last chapter gives a complete account of the different theories of magnetism. Weber's theory is discussed with modifications by Maxwell and Wiedemann, to which are added Prof. Ewing's own views of the subject. He goes on to show that the reduction of hysteresis by vibration is explained by the molecular theory of magnetism,—and further supposes that time-lag in magnetism can be accounted for by it. The book ends with an account of Ampère's hypothesis of magnetic molecules.

E. WILSON.

[1] For recent experiments upon Magnetic Viscosity see a paper by J. Hopkinson, F.R.S., and B. Hopkinson in *Electrician*, September 9, 1892.

OUR BOOK SHELF.

Forschungsberichte aus der Biologischen Station zu Plön. Theil I. Faunistische und biologische Beobachtungen am Gr. Plöner See. Von Dr. Otto Zacharias, Direktor der Biologischen Station. (Berlin: R. Friedländer und Sohn, 1893.)

THE first report of investigations from the biological station of Plön, in Holstein, has just been issued. It is a journal of 52 pages with one plate, bearing on the front of the cover a neat representation of the turreted three-storey building reflected in the quiet waters of the inland lake, and on the back a list of the regulations observed in the management of the station.

In his introductory remarks the Director, who has already made his views known with regard to the importance of freshwater laboratories in the pages of several German scientific periodicals, gives a brief sketch of the advance already made in this direction in Italy, France, and America.

The first paper gives a list of the fauna at present known to inhabit the lake. This occupies seven pages; and fourteen names, being printed in italics, signify that they are new to science. The new species and genera are treated in detail in the second paper. The greatest