I do not think Sir John Lubbock can know the facts of the case, or he would not permit his name to appear as the god-parent of a book thus flyblown; nor should its publishers continue to issue it, and this not because the book contains mistakes—all books do that—but because its mistakes have been pointed out, and because its author is a great deal more than Sir Robert Ball, and cannot therefore escape the penalty of such a position.

The Athenæum Club, HENRY H. HOWORTH.
October 4.

MacCullagh's Theory of Double Refraction.

AN attempt has recently been made by Mr. Larmor to resuscitate MacCullagh's dynamical theory of double refraction (Brit. Assoc. Rep., 1893; *Phil. Trans.*, 1894, A, part ii.), but on examination this theory appears to me to infringe one of the fundamental principles of dynamics, viz. the principle of angular momentum.

Whatever the constitution of the medium may be, the forces which act upon any element consist of two distinct classes: (1) forces due to the action of contiguous parts of the medium; (2) forces arising from causes external to the element. The forces comprised in the first class are usually termed stresses; they act upon the surface of the element, and are completely specified by the nine quantities X_x, X_y, &c. The forces comprised in the second class act upon each element of mass, and arise from attraction or repulsion due to external causes or to the action of the medium upon itself. These forces, from whatever cause they may arise, are capable of being compounded into a single force along a line through the centre of inertia of the element, and a couple about some axis through this point. In ordinary gravitating matter the couple vanishes.

The equations of motion of the element in terms of the stresses and the *force constituent* of external action are the analytical expressions for the principle of linear momentum; but this principle is not sufficient to determine the motion of the medium—it is further necessary to satisfy the principle of angular momentum, and any theory which violates the latter principle is dynamically unsound. Now the principle of angular momentum requires that three relations of the form $X_y = Y_x$ should exist between the six shearing stresses, thereby reducing their number from six to three, except in the following two special cases. The first case occurs when the medium, previously to being disturbed by the passage of a wave of light, is *not at rest*, but possesses an independent angular momentum; that is to say, the medium is what has been termed a *gyrostatic* one. The second case occurs when the resultant of the external forces which act upon the element consists of a *couple* as well as a force. In the first case the kinetic energy of the disturbed motion of an element will not be proportional to the square of its velocity of translation, but will contain a term depending on the gyrostatic momentum; whilst in the second case the potential energy must necessarily contain a term due to external action.

Mr. Larmor assumes that the kinetic energy of an element is proportional to the square of its velocity of translation, so that the medium he considers is not a gyrostatic one; whilst the potential energy is supposed to be a quadratic function of the rotations, and he obtains his equations of motion by means of the principle of least action. Now, as we have pointed out, the potential energy of an element *may* consist of two distinct parts, viz. one due to deformation, and the other due to the action of external causes; and it is quite legitimate to assume *by way of trial* that the former part contains rotational terms. But it is well known that a quadratic expression which contains rotational terms will not satisfy the conjugate relation between the six shearing stresses, and consequently the principle of angular momentum will be violated, unless every element of the medium is under the influence of some system of forces, of the kind belonging to the second class, the couple constituent of whose resultant *does not vanish*. The potential energy ought therefore to be of the form W + V, where W is the portion due to deformation, whilst V is the portion due to external causes which supplies the couple which is necessary in order to prevent the principle of angular momentum being violated; and unless Mr. Larmor is able to surmount this difficulty, I am at a loss to understand how his paper is an improvement upon theories which are at any rate *dynamically sound*, whatever other imperfections they may possess. The question is one which cannot be disposed of by pages of vague and obscure generalities, but requires a detailed and careful mathematical investigation for its elucidation. A. B. BASSET.

Holyport, Berks, October 3.

The Southern Carboniferous Flora.

SO far as I am aware, Dr. Kurtz's paper on the newly discovered Carboniferous Flora in Argentina had not been noticed in print in this country until the appearance of the number of NATURE for September 26, which contained a note (p. 523) giving a brief abstract from the translation published in the Records of the Geological Survey of India. The circumstance that the original paper, which appeared nearly a year ago, was in Spanish, may have caused its being overlooked.

The subject of the ancient Southern floras is naturally unfamiliar to most European geologists, and I hope I may be allowed to point out why the present discovery is important. It completes a mass of evidence gradually accumulated. It is, of course, well known that several successive floras of Upper Palæozoic and Lower and Middle Mesozoic Age have been found associated with beds mainly of freshwater origin, some of which combine valuable coal seams, in India, Australia, and South Africa. The most ancient of these beds in Australia and South Africa contain certain plants, amongst them a *Lepidodendron*, allied to the ordinary Carboniferous flora of Europe and North America. From the upper beds in all the three regions named, Ferns, Cycads, and a few other plants have been obtained that are related to the Rhætic and Jurassic types found in European rocks. Between the upper and lower plant-bearing strata in South Africa and Australia, and beneath the upper series in India, are found beds, with coal seams in places, containing by far the most remarkable flora of the whole, the Glossopteris-flora, as it has been called. The particular interest attaching to this flora is mainly due to two circumstances. (1) It is clearly Upper Palæozoic, for in Australia the coal measures containing it are interstratified with marine beds abounding in carboniferous fossils, and yet it differs radically from any known European or North American flora of that age. (2) The basal beds, in India, Australia, and South Africa, are boulder beds, resembling the Pleistocene glacial boulder clay more than they do any other formation.

Now in Argentina the occurrence of the Southern Jurassic or Rhætic flora has been known for some years, and Prof. Derby has called attention to the presence in Southern Brazil of a great boulder bed, that very probably corresponds in character and geological position to the Talchir beds of India and the Dwyka beds of South Africa. More recently traces of the ancient Lepidodendron flora have been discovered in Argentina, and some additions to that flora are described in Dr. Kurtz's paper. But the important announcement in this paper is the discovery in Argentina of three Indian lower Gondwána plants, *Neuropteridium validum*, *Gangamopteris cyclopteroides*, and *Nœggerathiopsis hislopi*, all three associated in India with the Karharbári coal-seams near the base of the Lower Gondwána. Two of the species are also found or represented by closely allied forms in Australia and South Africa. In Argentina, as in India, Australia, and South Africa, there is a remarkable absence in this particular flora of forms characteristic of the Upper Palæozoic of Europe, no representative of Lepidodendron or Sigillaria occurs, and the Ferns, Cycads, and Equisetaceæ that constitute the flora are related to European Mesozoic types.

It is difficult to understand how two floras differing from each other far more widely than do any two continental floras living on the earth's surface at the present day, can have coexisted unless there was, for a long period of geological time, a great southern continent—the Gondwána-land of Suess—isolated by a wide sea, probably an ocean, from the land that occupied in Carboniferous and Permian days so wide an area in the northern hemisphere. The importance of the new discovery is the immense extension that it gives to Gondwána-land, and the proof it affords that the region with its flora extended to the western hemisphere, and included a part, at all events, of South America. This appears to indicate that a considerable area now occupied by ocean in the southern hemisphere was land in the Carboniferous period. Further research is needed to show whether the various tracts of Gondwána-land were connected by a South Polar land area. W. T. BLANFORD.

October 4.