many experimental contrivances, by which the remarkable phenomena known as "gyrostatic" — *i.e.*, the stable properties of bodies in rapid rotary motion[1] —could be studied, as also to the development of the theory of knots and linkage.[2] In the resourceful brain

(and electricity) is atomic (discrete, grained), Dr Larmor has traced the modern vortex theory further back beyond Rankine to James MacCullagh, who in his 'Essay towards a Dynamical Theory of Crystalline Reflexion and Refraction' (Trans. Irish Academy, 1839), "arrived at a type of elasticity (of the ether) which was wholly rotational, . . . somewhat after the manner that a spinning flywheel resists any angular deflection of its axis" (p. 26 of his Adams prize essay 'Æther and Matter,' 1900). "Rankine, never timid in his speculations, expounded MacCullagh's analytical scheme soundly and clearly, in full contrast with the elastic properties of matter, as representing a uniform medium or *plenum* endowed with ordinary inertia, but with elasticity of purely rotational type" (ibid., p. 77; cf. p. 73); but he also remarks that "up to the period of Lord Kelvin's vortex atoms . . . the earlier theories . . . could only have been hypothetical speculations" (p. 25 note).

[1] Helmholtz himself did not give many practical illustrations of his remarkable theories. Such were first given by W. B. Rogers ('Amer. Journ. of Science' (2), vol. 26, p. 246) in 1858, without knowledge of Helmholtz's theoretical investigations. In this country such illustrations have become quite favourite popular lecture experiments (see Sir Rob. S. Ball's memoir). Smoke-rings, solid and liquid gyrostats, and a host of similar contrivances, have impressed on us the hidden resources of whirling motion. Prof. Tait, in his 'Recent Advances of Physical Science' (3rd ed., 1885, p. 296), states that experiments on smoke-rings which he performed, suggested to Lord Kelvin the vortex theory of matter. The various papers of the latter have, so far, not been collected in a convenient form. The earliest is contained in the 'Proceedings of the Royal Society of Edinburgh,' February 1867. Then followed a memoir in the 'Transactions' (April 1867) on vortex statics (Proc. R. S. E., December 1875); "Vibrations of a Columnar Vortex" (Proc., March 1880). Prof. Hicks, and especially Prof. J. J. Thomson (Trans. R. Soc., 1884; 1881), have contributed to the theory, and the latter, in his Adams prize essay for 1882, has further tested the conception in its application to chemical statics. See Hicks, 'Recent Progress in Hydrodynamics' (Brit. Assoc. Rep., 1881, p. 63, &c.), and J. J. Thomson 'On the Motion of Vortex Rings' (1883, p. 114, &c.)

[2] The creator of this branch of purely positional geometry is doubtless Johann Benedict Listing, who was led to his researches by some suggestions of Gauss. Gauss refers to the subject in connection with his unpublished researches into electrodynamics (1833, posthumously published in 'Werke,' vol. v. p. 605). Listing called this branch of geometry "Topologie" (cf. Listing, 'Vorstudien zur Topologie,' Göttingen, 1847). In the meantime Riemann had been (1851) led in his mathematical representation of functions on the surface called