the relativity of motion it is manifestly the same thing to say (1) that referred to axes fixed in the earth all the stars describe circles every day about the polar axis, or (2) that referred to axes fixed among the stars the earth rotates about its polar axis once a day. If any ground can be alleged for holding that one of these statements is the simpler, that is a ground for a certain choice of axes, not for saying that one motion is "real" or "absolute," and the other "relative" or "apparent."

All the so-called "proofs of the earth's rotation" are deductions from particular experiences which show that other motions besides the diurnal relative motions of the earth and stars are more simply expressed by referring to axes fixed among the stars than by referring to axes fixed in the earth. They all depend on the specification of "the acceleration due to gravity" near the earth's surface. The neighbourhood of the earth is a field of force, and the magnitude and direction of the force at any point depend on the axes of reference. The specification of the field of force is simplest when referred to the centre of the earth as origin, and to axes fixed in direction with reference to the stars. The field is then expressed by the law of gravitation.

It is worth while to elucidate this matter in greater detail by an examination of the most famous of these "proofs," that by means of Foucault's pendulum. What is observed is that if the pendulum is really free to swing about a point, and if the bob always passes above the same point of a horizontal table (fixed with reference to the earth) when at the lowest point of its swing, then the plane of vibration turns slowly round, so that the line of vibration is above now one, now another line drawn on the table, the oscillation in the line being practically simple harmonic. If this motion were referred to axes fixed with reference to the table, there would be a component acceleration from the bob of the pendulum towards the point of support (to be accounted for by the constraint), a component acceleration in the plane of vibration at right angles to the former (which we should recognise as a component of gravity), and a component acceleration perpendicular to the plane of vibration, and proportional at any instant to the velocity in the simple harmonic motion. If we had nothing else to guide us, no observation of the stars, no theory of gravitation, but knew only from less refined observations that free bodies fall downwards with constant acceleration, we should have to do two things: we should have to try to simplify the specification of the acceleration of the bob of the pendulum by referring to a new set of axes, and we should have to conclude that our previous observations of falling bodies had not disclosed all the facts about the field of force in the neighbourhood of the earth. We should simplify the specification of the observed accelerations by referring to axes which (relative to the earth) rotate with the plane of vibration of the pendulum, and we should conclude that such axes are required in order that the laws governing the motion of falling bodies may be correctly formulated. What the experiment with Foucault's pendulum really proves is not that the rotation of the earth relative to the stars is an "absolute motion," but that the system of axes, with reference to which the acceleration of a free body near the earth's surface is of constant amount and directed towards the earth's centre, is not fixed in the earth, but (relative to axes fixed in the earth) these axes rotate with the stars.

It will be found on examination that every other so-called "proof of the earth's rotation" is of the same character. By each it is shown that the earth rotates in the same time and in the same way relative to the axes required for the statement of the law of gravitation as relative to the stars. It is not legitimate to suppose that two relatives make one absolute.

It is true that the conclusion at which we have arrived takes longer to state, and appears at first sight less simple than the statement by way of "absolute motion," but it contains no undefined terms, and no reference to anything assumed to exist, but about which nothing can be known.

Objection has been taken to the attempt to express mechanical theory in terms of relative motion, on the ground that it will be perplexing to beginners, and difficult at any stage. In answer to this it may be urged that in teaching beginners there is no need to say anything about either relativity or absoluteness. The motions that interest them are motions relative to the earth; the motions of boats, trains, cricket-balls, billiard-balls, and machinery; things that can be sufficiently described by reference to lines fixed in the earth. It is only at a later stage when general mechanical theories have to be studied, and a foundation laid for physical astronomy and mathematical physics, that it is proper to insist on the relativity of motion; and at this stage it appears to me more important that our statements of principles should be free from metaphysical obscurity than that they should be verbally short.

A. E. H. LOVE.

The Antiquity of the "Finger-Print" Method.

SIR WILLIAM HERSCHEL, in his letter to NATURE (Nov. 22, p. 77), expresses his unbelief in the statement in the *Nineteenth Century* (No. 211, p. 365), which ascribes to the Chinese the original invention of the "finger-print" method of personal identification. While I do not know upon what Mr. Spearman has founded this statement, I have collected from a few sources some facts which seem to justify the claim made on behalf of the Chinese.

Although at present I have no record to refer to, it is a fact that every Japanese, old enough to have outlived the *ancien régime* that passed away in 1869, well remembers the then current usage of "stamping with the thumb" (*Bo-in*) on legal papers, popularly called "nail-stamp" (*Tsume-in*), on account of the common use of a thumb with the edge of its nail in ink; whereas on papers of solemn contract, accompanied by written oath, the "blood-stamp" (*Keppan*), or the stamp of the ring-finger in blood drawn therefrom, was demanded.[1]

Chûryô Katsurakawa, the Japanese antiquary (1754–1808), writes on the subject as follows: "According to the 'Domestic Law') (*Kore*), to divorce the wife the husband must give her a document stating which of the Seven Reasons[2] was assigned for the action. . . . All [letters] must be in the husband's handwriting, but in case he does not understand how to write, he should sign with a finger-print. An ancient commentary on this passage is: 'In case a husband cannot write, let him hire another man to write the document . . . and after the husband's name sign with his own index-finger.' Perhaps this is the first mention [in Japanese literature] of the 'finger-print' method" (1) This "Domestic Law" forms a part of the "Laws of Taihô" enacted in 702 A.D.; with some exceptions, the main points of these "Laws" were borrowed and transplanted from the Chinese "Laws of Yung-Hwui" (*circa* 650–55 A.D.) (2); so it appears that the Chinese of the 7th century A.D. had already acquired the "finger-print" method.

After the above-quoted passage, Katsurakawa continues thus: "That the Chinese apply on divorce-papers the stamps of the ends of the thumb and four fingers, which they call 'Shau-mú-ying' (*i.e.* hand-pattern stamp) is mentioned in 'Shwui-hü-chuèn,' &c." (3). This "Shwui-hü-chuèn" is one of the most popular novels enjoyed by the modern Chinese—so popular that I have met with many Chinese labourers possessing it in the West Indies; its heroes flourished about 1160, and its author lived in the twelfth or thirteenth century A.D. (4). As is usual with many other examples, this novel gives us more accurate descriptions of minor institutional features that co-existed with either the heroes or the author, or both (5). After making careful search in this novel, I can now affirm that the Chinese in the twelfth or thirteenth century used the finger-prints, not only in divorce, but also in criminal cases. Thus the chapter narrating Lin Chung's divorce of his wife, has this passage: "Then Lin Chung, after his amanuensis had copied what he dictated, marked his sign-character, and stamped his 'hand-pattern'" (6). And in another place, giving details of Wu Sung's capture of the two women, the murderers of his brother, we read: "He called forth the two women; compelled them both to ink and stamp their fingers; then called forth the neighbours; made them write down the names and stamp [with fingers]" (7).

It has been lately suggested by my friend, Mr. Teitarô Nakamura, that possibly the "finger-stamp" was merely a simplified form of the "hand-stamp," which latter method had once been so current in Japan that it gave to the documents the common names "Tegata" (*i.e.* hand-pattern) and "Oshite" (*i.e.* impressed hand)[3] (8). This view applies equally well to

[1] The "thumb-stamp" was equally regarded with the formal engraved seal (*Jitsu-in*), but the "blood-stamp" had nothing to do for identification. For the formula of the latter mode of stamp, *vide* Ota, "Ichiwa Ichigen," new edition, Tokyo, 1882, vol. xiii. p. 39.

[2] The Seven Reasons for divorcing the wife are: (1) filial disobedience; (2) barrenness; (3) licentiousness; (4) jealousy; (5) leprosy; (6) loquacity; (7) larceny.

[3] It must not be presumed as a fact that after the "finger-stamp" was introduced, it soon supplanted the "hand-stamp"; for even in the seventeenth century the latter was sometimes used, as is instanced in the writing of Katô-Kiyomasa (1562–1611) preserved in a monastery near Tokyo. *Cf.* Kitamura, "Kiyû Shôran," new edition, 1882, vol. iv. p. 16.

the case of the Chinese, for they still use the name "hand-pattern" for the finger-print (see above). That this "hand-stamp" was in use in an ancient kingdom of Southern India, there is a proof in the Chinese records (9).

When we recognize that the hand-marks were early in use for identification by the three distinct nations, the Japanese, Chinese, and Indians, and when we consider that even the teeth-marks were so commonly used for authentication in India that the heir-apparent to As'ôka Râdja did not hesitate in plucking out his own eyes on recognizing the king's teeth-mark that accompanied the false epistle (10), it would seem quite true that among those ancient nations who were, with few exceptions, ignorant of the use of "written signature" method, it was but a natural process that the methods were invented to apply to identification some more or less unchanging members of human body.

Further, that the Chinese have paid minute attention to the finger furrows, is well attested by the classified illustrations given of them in the household "Tâ-tsâh-tsú"—the "Great Miscellany" of magic and divination—with the end of foretelling the predestined and hence *unchanging* fortunes (11); and as the art of chiromancy is alluded to in a political essay written in the third century B.C. (12), we have reason to suppose that the Chinese in such early times had already *conceived*—if not perceived—the "for ever unchanging" furrows on the finger-tips.

Bibliography.—(1) "Keirin Manroku," 1800, new edition, 1891, p. 17. (2) Y. Hagino, "Nihon Rekishi Hyôrin," 1893, vol. vi. pp. 2, 24. (3) Same as (1). (4) Takizawa, "Gendô Hôgen," 1818, vol. ii. chap. xli. (5) *Cf.* Davis, "China," vol. ii. p. 162; Bazin, "Théâtre Chinois," Introduction, p. li. (6) Shi-nái-ngán (?), "Shwui-hü-chuèn," Kin's edition, Canton, 1883, tom. xii. p. 4. (7) *Ibid.*, tom. xxx. p. 18. (8) *Cf.* Terashima, "Wakan Sansai-dzue," 1713, tom. xv. art. "Tegata." (9) Twan Chîng-Shih, "Yú-yáng Tsáh-tsu," ninth century A.D. tom. xiv. (10) Hiuen-tsang, "Sí-yú-kí," sub. "Takchas'ila"; Hirata, "Indo-zôshi, MSS. vol. xxi. pp. 10–11, 26. (11) Terashima, *op. cit.* tom. vii. art. "Ninsômi." (12) "Kan-fei-tze," tom. xvii. sub. "Kwei-shi."

KUMAGUSU MINAKATA.
15 Blithfield Street, Kensington, W., December 18.

Peculiarities of Psychical Research.

MAY I enter an emphatic protest against the notion insinuated both by Mr. Wells and Prof. Karl Pearson, that "Psychical Researchers" are a sort of sect engaged in spiritualistic or other propaganda? Most people, I am afraid, fight shy of psychical research, either because they are afraid that *if* there is anything in it it is the devil, or because they have a scientific reputation which they are afraid of losing. I do not know to which category Mr. Wells belongs, but apparently he fails to understand that in order to make out a case against psychical research he has got to show, not that the existence of telepathy and clairvoyance has not been proved, but that there is not even a *prima facie* case worth investigating. When we remember that ten years ago "mesmerism 'was included along with telepathy and clairvoyance, we shall not attach much importance to such efforts to stifle inquiry. Even if the result should be to confirm Mr. Wells's anticipation, and show that all the coincidences that have been reported can be explained away as mistakes or misstatements, the inquiry will yet have been worth the labour bestowed on it, if only as affording a measure of the value of testimony to the miraculous. And if this comes to pass, the bigots of science will be ready enough to claim a share in the work, if only by saying, "I told you so!"

I do not know what Prof. Karl Pearson means by his quite gratuitous attack on "the scientific acumen of the psychical researchers." Surely he cannot imagine that they overlooked the point which he has unearthed? The instructions to the experimenters were, that "the agent should draw a card at random, and cut the pack between each draw" ("Phantasms of the Living," vol. i. p. 33, foot-note). Could an abnormal distribution of the cards affect the result if those precautions were taken, or has the Professor any reason to suppose the instructions were not carried out? EDWARD T. DIXON.

Cambridge, December 14.

THE following are a few of my grounds for questioning the scientific acumen of the psychical reseafchers:—(1) M. Richet's experiments are cited as if they were significant of telepathic action. On the contrary, they give odds of so little weight that they are significant of nothing but want of acumen. I have in card drawing, tossing and lottery experiments, all conducted with every precaution to secure a random distribution, obtained results against which the odds were more considerable. (2) Mr. Dixon is unable to see the importance of ascertaining whether there was an abnormal distribution in the cards cut or the cards guessed. His inability is a strong confirmation of my standpoint. (3) I have heard lectures, and read papers written by psychical researchers. Both alike seem to me akin to those products of circle squarers and paradoxers, with which, as a reviewer, I am painfully familiar. As a concrete example, I take my friend Dr. Oliver Lodge's psychical papers. They are typical, to my mind, of the manner in which the scientific acumen of even a professed and most highly competent man of science vanishes when he enters this field of "research."

I do not intend to take part in a controversy on the subject at the present time, but I do suggest that no better exercise could be found for a strictly logical mind with plenty of leisure than a criticism of the products of the chief psychical researchers. Such a criticism would be of much social value, in the light of recent attempts to popularise the "results" reached by these investigators. KARL PEARSON.

University College, London, W.C. December 19.

The Artificial Spectrum Top.

I HAVE read with interest Prof. Liveing's theory of my artificial spectrum top as summarised in NATURE of Dec. 13, p. 167, and am sorry I did not know of his conclusions before he made them public, because a very simple experiment would, I think, have convinced him of their inaccuracy. If Prof. Liveing, or any of your readers, will examine my top rotated in the light of a *bright* sodium flame, they will find that the colours are quite distinct. I know of no other way of seeing blue and red by the light of sodium, and the phenomenon, I think, shows decisively that the colours of the top are "artificial" sensations in the sense explained in my theory of the instrument.

December 16. CHARLES E. BENHAM.

I HAVE examined Mr. Benham's top by the light of a bright sodium flame, but have failed to see anything like the colours which I see by daylight or by the light of an incandescent electric lamp. By the sodium light the outmost three circles appear, when the rotation is one way, to be dark brown, the inmost three dark leaden grey, while the intermediate circles are paler brown. Reversing the direction of rotation interchanges the appearances of the outmost and inmost three circles. I cannot see any red or blue, or green, in any case. Other people here seem to see much the same as I do when the top is illuminated by the sodium flame only. With certain black and white figures of my own, I can get a pink appearance in the sodium light, but no green or blue. With spiral figures, which are worrying to look at, I find that some people can see a play of colour even with the sodium light, but I do not see it myself. Using a turn-table, by which the rate of rotation can be regulated at will, I have found that the speed, in white light, required to bring out the colours is decidedly different for different people. This fact convinced me that the explanation of these very curious appearances must be looked for in some physiological cause. It is perhaps worth remark that a sodium flame, when there is much sodium in it to make it bright, is by no means monochromatic, though sufficiently so to make the experiment with the top a very interesting one; and as Mr. Benham sees colours by this light which some others fail to see, it goes far to prove the phenomenon to be subjective.

Cambridge, December 19. G. D. LIVEING.

"Solute."

CORRESPONDING to the words "solvent" and "solution," some word is very badly wanted to express "the dissolved substance." The analogous word is evidently "solute," and it is as short and euphonious as the others. May I inquire why it is not in general use? Surely some one must have proposed it?

Leipzig. F. G. DONNAN.