stretched positions, and it is thus that the artist should represent them. It is his duty to represent things as they *appear*, rather than as they actually *are*, at a given instant of time.

The fan-shaped form noticed in the case of the oscillating pencil becomes exceedingly indistinct, if it does not disappear altogether, in the case of the galloping horse's legs. This is owing to the rapid internal changes of form of the legs.

Your correspondent, Sir W. G. Simpson, Bart., states in his excellent letter produced in NATURE, vol. xxi. p. 55, that a galloping horse might be represented with all its legs gathered under it. I venture to disagree with him for this reason: the two "minimums" to which I have referred in a former part of this letter are *not* coincident when the legs are in their extreme position gathered under the body, and therefore no such distinct image of them in that position is produced. The "minimums" are only coincident in the other extreme, viz., the outstretched, position.

The artistic representation of a horse's paces other than galloping, as also that of other objects in motion, can be determined by similar reasoning. V. B. BARRINGTON-KENNETT

15, Hyde Park Gardens, W., November 26

Force and Momentum

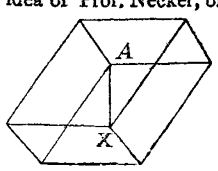
IT is commonly said that change of momentum is evidence that force has acted or is acting on the mass, and that the rate at which the momentum is changing is the measure of the force. Thus, in his lecture on "Force," Prof. Tait says: "Force is the rate of change of momentum" (NATURE, vol. xiv. p. 462). This is not true if the mass be variable. Suppose a sphere of ice moving with constant velocity in a straight line through hot space. The mass, and therefore the momentum, is changing at every instant by the evaporation of the ice. The evaporation being supposed uniform over the entire surface, any force impressed on the sphere by the mutual repulsion between it and a particle of vapour thrown off at a point, p, is balanced by an equal force at the other end of the diameter through p. Hence, the resultant of all these forces is nothing. Here, then, we have change of momentum of the sphere, although no force acts on it. In like manner the change of momentum of a rocket and of a locomotive engine is partly due to change of mass. Does it not hence appear that change of *velocity* is the proper evidence of the action of force? When a variable mass, m, is in motion, the proper measure of the force acting on m at any given instant in any given direction is—not the rate of change of momentum, but—the product of the value of the mass at that instant, and the value of the rate of change of the velocity at that instant and in that direction, *i.e.*, the measure of the force is not $\frac{d(mv)}{dt}$, but $m\frac{dv}{dt}$.

E. G.

[There is no such thing in nature as a "variable mass"; and our correspondent's difficulty arises from his omitting to take account of the momentum of each of the parts (however small) into which a mass may be divided. In most good works on dynamics he will find the motion of a rocket, or of a descending rain-drop (which gathers mass as it falls), accurately treated on the assumption that the momentum produced per unit of time is the measure of the force acting.—ED.]

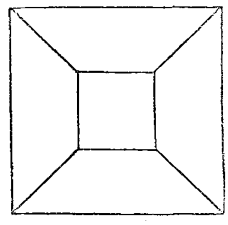
Change in Apparent Position of Geometrical Figures

THE perplexing illusion to which Mr. Bellamy refers (NATURE, vol. xx. p. 362) has long been known, and various explanations have been given of it by physicists. Sir Chas. Wheatstone, in 1838, showed clearly that it is a mental operation, while combating the idea of Prof. Necker, of Geneva, who attri-



buted the alteration of appearance in geometrical figures, not to a mental operation, but to an involuntary change in the adjustment of the eye for obtaining distinct vision. Necker's experiment is substantially the same as that described by Mr. Bellamy. The solid angles at A and X being alternately looked at, sometimes one and sometimes the other appears the nearer, the entire figure at the same time changing in unison; and as Wheatstone points out, "the change of figure frequently occurs while the eye continues to look at the same angle."

In the following experiment it is seen more clearly still that the operation is a mental one, because there is neither movement of recti, oblique, nor ciliary muscles. Two concentric squares have their corners joined by straight lines. The lesser square



will appear in a plane anterior, or posterior to the larger, according as we regard the figure as the representation of a truncated pyramid, or as the representation of a room with its sides all sloping away to the distant square wall. Here no eye muscles are concerned; the image on the retina remains unaltered, and the only operation is a mental one, a turning to the results of past experience. WM. ACKROYD

Mutual Attraction of Spectral Lines

I DO not know that it has been remarked that a line in the diffraction-spectrum (whether bright or dark) must be shifted from its normal position in case another line falls very near it. Neighbouring lines must be attracted if both are bright or both dark, and repelled if one is bright and the other dark. The reason is that the lines are only maxima or minima of light, and the differential coefficient of the sum does not vanish at the same points as the differential coefficients of the separate terms. The shifting will be the greatest in the case of a faint line near a very intense one. I have succeeded in this way in shifting the positions of lines by measurable amounts (1″ to 2″).

Baltimore, Md., November 14 C. S. PEIRCE

EXPLORATION OF TIMOR

IT will be perhaps of some interest to the readers of NATURE to hear that Mr. Riedel, the Dutch resident on Timor (Timor Kupang), who formerly lived on Celebes, and collected a great deal on this island for European museums, and who is known by his various writings on different scientific questions concerning the East, has just returned from a twenty-five days' journey through Central Timor from 123° 30′—125° E.L., as he wrote to me in a letter dated October 6. No European has made such a journey through Timor before, and it has been very troublesome. But the country is, Mr. Riedel remarks, a splendid one, and very suitable for coffee and cinchona cultivation. The traveller did not see any Negritos, who, according to the assertion of M. Hamy, live in the interior of Timor, nor did he hear anything of a Casuary which was reported from there recently. Mr. Riedel collected many geographical notes, and sketched a map of the parts which he visited. A small collection of plants was forwarded to me by Mr. Riedel, and I have sent them to Kew, as Prof. Oliver formerly had the kindness to determine several botanical collections of Mr. Riedel's from Celebes. A. B. MEYER

Dresden, November 29,
Royal Zool. Museum

LAND SHELLS OF THE AUSTRAL ISLANDS

THE small island of *Rurutu* (Oheatora of Capt. Cook) is about 320 miles south-south-west of Tahiti; it is eight miles in length, and has an elevation of 1,500 feet, over 100 feet consisting of old coral reefs which have been upheaved to that altitude. Mr. Charles de Gage, a resident and experienced naturalist, has collected a number of land-shells, which have been studied

by Mr. Andrew Garrett, and described in the *Proc.* Acad. Nat. Sci. Philadelphia. One of the most interesting species is *Partula hyalina* (Broderip), found abundantly in three groups of islands. In Tubuai, 100 miles east of Rurutu, it is abundant, and the Austral group appears to be its metropolis. It is found, though sparingly, in nearly every valley in Tahiti. It was also obtained by Mr. Garrett at Mangaia, one of the Cook's, or Hervey Islands, 400 miles *west* of Rurutu. The variation in examples from the three groups is remarkably slight. It is a strictly arboreal species, and has a uniform white colour.

Another species, *Stenogyra juncea*, Gould (sp.), is found very widely through Polynesia, in all groups north of the equator, and south of all islands from the Marquesas and Paumotus, to the Viti group, and probably ranging further west; they are found under loose stones, beneath decayed wood, among dead leaves, &c., and range from near the sea-shore to 2,000 feet above the sea. Another well-known genus, *Succinea*, is now recorded from Rurutu, slightly differing from a Tahitian species, *S. pudorina* (Gould).

Chondrella (Pease) is remarkable for having no tentacles; during locomotion the animal is nearly or quite concealed by the shell, which is carried diagonally. In creeping, only the extreme tip of the muzzle is seen from above, while the eyes are plainly visible through the transparent shell. The extreme interest of the fauna of oceanic islands becomes continually more evident.

DISTINGUISHING LIGHTS FOR LIGHT-HOUSES

SIR WILLIAM THOMSON writes a long letter on this subject to the *Times* of Tuesday, the letter being the result of a most interesting experimental cruise of ten days on board Her Majesty's ship *Northampton*, in the English Channel, from which he has recently returned, having had many good opportunities of observing the lights on the south coast of England. This has revivified his conviction of need for a threefold reform in our light-house system, which he has been urging and re-urging since 1872 with hitherto but partial success:—A great quickening of nearly all revolving lights; the application of a group of dot-dash eclipses to every fixed light; and the abolition of colour as a distinction of lighthouse lights, except for showing dangers and channels and ports by red and white and green sectors. Of about 120 revolving lights on the English, Scottish, and Irish coasts, there are in all eighteen in which the periods are ten seconds or less and the times of extinction seven seconds or less. In these quick revolving lights the place of the light is not practically lost in the short intervals of darkness; the eye sweeping deliberately along the horizon, with or without the aid of a binocular, to "pick up the light," passes over less than the breadth of its own field of view in the period of the light, and thus picks it up almost as surely and quickly as if it were a fixed light. And so in respect to compass bearings, whether taken roughly and quickly by inspection or more accurately by azimuth compass, the bearing of the ten-second or quicker revolving lights is taken almost as easily and accurately as if the light were continuous. Sir William contrasts this with the case of the ordinary minute-period revolving light, or even the half-minute period to which some formerly slower lights have been quickened. He shows how difficult it is to pick up these slow lights, and his own experience proves that a fixed light like the Eddystone is much more valuable than the slowly revolving Start.

The Wolf light he found most irregular in its periods, the successive periods of light varying from nineteen to forty seconds, and of darkness from nineteen to thirty-four. These irregularities are apt to lead to most serious mistakes, as Sir William shows.

"Except in one unimportant case—the Dungeness Low Light, which flashes every five seconds—all the revolving lights of the English Channel are too slow, and it would be an unspeakable improvement if, with that exception, every one of them had its speed sextupled. There is no mechanical difficulty in the way of doing this. Generally the same mechanism would suffice with a mere change of adjustment of the governor; but the lightkeeper would have to wind up the weight oftener or longer.

"Revolving lights are, however, but a small minority of all the lighthouses of the world. Of the 623 lights of the British and Irish coasts, just 110 are revolving lights, and the remaining 513 are fixed, and there is a crying want of distinction for fixed lights. The distinction by colour alone ought to be prohibited for all lighthouse lights, on account of its liability to confusion with ships' and steamers' side-lights. Southsea Castle, with its red and green port and starboard side lights, seems as if actually planned to lure on to destruction an unsuspecting enemy carefully approaching the coast with Thomas Gray's happy rule well impressed on his mind:—

"'Green to green, and red to red,
Perfect safety, go ahead.'

He does so, and is wrecked on Southsea beach.

"My proposal for supplying the want is to distinguish every fixed light by a rapid group of two or three dot-dash eclipses, the shorter, or dot, of about half a second duration, and the dash three times as long as the dot, with intervals of light of about half a second between the eclipses of the group, and of five or six seconds between the groups, so that in no case should the period be more than ten or twelve seconds. This proposal has been carried into effect with perfect success in Holywood Bank Light, Belfast Lough, now the leading light for ships entering the Lough, but which until 1874 was inclosed in a red glass lantern and was only visible five miles, and was constantly liable to be mistaken for a sailing vessel's port side light entering or leaving the harbour of Belfast, or the crowded anchorage of Whitehouse Roads. In 1874 the red glass was removed, and the light was marked by dot, dot, dash (— — ———, or letter U), repeated every ten or twelve seconds, and has been so ever since. It is now recognised with absolute certainty practically as soon as seen in ordinary weather from the mouth of the Lough, ten miles off, and has proved most serviceable as leading light for ships bound for Belfast or entering the Lough.

"It is much to be desired that the dot-dash system should be seriously considered by the lighthouse authorities of our islands. Hitherto, when attention has been called to it, it has been dismissed with a pleasantry, 'Winking lights won't do,' or else something utterly different has been gravely considered and justly condemned. It is satisfactory now to know that the Deputy-Master of the Trinity Board, Sir Richard Collinson, K.C.B., has, after its character was correctly put before him by the recent Select Committee of the House of Commons on Electric Lighting, given it his approval in the concluding answers of his evidence."

The *Times*, in commenting on Sir William Thomson's letter, speaks of the subject as one of great national importance, Sir William speaking with the twofold authority of a distinguished man of science and of a practical yachtsman. The *Times* endorses emphatically all Sir William's recommendations, and insists especially on doing away with colour as a distinctive feature of lights.

"If," the *Times* concludes, "the recommendations of Sir William Thomson should eventually lead to a reform of this importance and magnitude, he will be a benefactor to humanity; but even without this his advice cannot fail to commend itself to navigators. It bears one of the most distinctive marks of genius—simplicity; and now that it has been brought fairly under the notice of the public, we may confidently hope that in the future, what-