

appear in positions much higher than their actual positions, that is to say, when images of them appear considerably raised above their true positions. The effects of looming are very extraordinary, and I have some slides to show you which I have prepared from examples recorded by Commander William Scoresby, who went on his third voyage in his ship the *Baffin* to the Greenland whale fishery in the spring of 1822. The first of these views includes several large irregularly-shaped icebergs, which must cause very unusual distributions of air density, and gave rise to quite remarkable vertical and lateral refractions. In the second there are images of ice which was quite out of sight or quite beyond the horizon. There was extraordinary vertical magnification; small hummocks of ice were drawn out into spires, sometimes of a castellated shape and sometimes having the appearance of naked trees; at other times there appeared to be a city of ice, with public edifices, spires, &c., and Commander Scoresby states in his book that these effects were constantly changing, and were never the same for two minutes together. The first of these drawings, which you saw on the screen, showed a curious inverted image of a ship in the sky, raised considerably above the horizon; that ship was so distant that it could not be seen with a powerful telescope.

During the Crimean War observers on one occasion saw the whole of the British Fleet inverted at a considerable height, an illustration of which appeared in *The Illustrated London News* at the time. Some very interesting cases were recorded by Dr. Vince in the Bakerian lecture of 1798, read before the Royal Society, some of which are delineated in the succeeding slides. He remarks upon these curious phenomena that he thinks that in cases of national emergency certain people should be told off with telescopes to look out for the enemy's ships, and to search the horizon to see if they could detect any ships looming. Dr. Vince mentions another remarkable instance in which he saw Dover Castle from Ramsgate, at a point from which the whole of the keep of the castle cannot be seen, the four turrets only being visible. The most curious case of lateral refraction that I have been able to discover was observed at Geneva in 1818, by M. Jurine; a barque was seen approaching on the left bank of the lake, and at the same time an image of the sails was observed above the water, which, instead of following the direction of the barque, separated from it and appeared to approach Geneva by the right bank of the lake, the image moving from east to west while the barque moved from north to south. This case was brought to the notice of Biot, the physicist, and he, in one of the scientific journals, gave a very long explanation. He came to the conclusion, from the geographical features, and climatology, and the direction in which the sun's rays were passing at the time of the observation, that there would be considerable lateral difference in the temperature, quite sufficient to produce this phenomenon of lateral refraction.

Another case of curious refraction has been noticed by many people—I have seen it myself particularly on the coast of Norway. Low lands, and the extremity of headlands, or points forming an acute angle with the horizon of the sea, and viewed from a distance beyond it, appear elevated above it, with an open space between the land and sea, the effect being proportional to the amount of evaporation taking place at the surface.

Fata Morgana is a name given to an optical phenomenon sometimes seen in the Straits of Messina between Sicily and the Italian coast. Minasi says: "When the rising sun shines from that point whence its incident ray forms an angle of about 45° on the sea of Reggio, and the bright surface of the water is not disturbed either by wind or current, the spectator being placed on an eminence of the city with his back to the sun and his face to the sea, on a sudden there appear in the water various multiplied objects, namely, numberless series of pilasters, arches, castles, columns, towers, palaces with balconies and windows, valleys of trees, plains with herds and flocks, &c., in their natural colours and proper action, passing rapidly in succession along the surface so long as the above-mentioned causes exist. If, in addition, the atmosphere be highly impregnated with vapour and dense exhalations not previously dispersed by the action of the wind and waves, or rarefied by the sun—in this vapour, as in a curtain, to a height of 24 or 25 feet, and nearly down to the sea, the observer sees the same objects not only reflected from the sea, but likewise in the air, though less distinct. Lastly, if the air be hazy and slightly opaque and dewy, the objects appear only at the sea surface, but with prismatic colours." He endeavours to prove that they are representations

of objects on the two coasts. He considers the sea an inclined speculum, on account of the rapid current which runs through the Straits, and divided into different planes by contrary eddies, and he ascribes the *aerial morgana* to the refractive and reflective power of matter suspended in the air.

Lastly, I would mention the experiments of Wollaston upon the subject of refraction and mirage. First, he says, into a square phial containing a little clear syrup put an equal quantity of water in such a way that it floats without mixing, and after a little time, by mutual penetration, you see effects; if you view through the syrup a card with a written word upon it, you see it, and also above it an inverted and erect image of the same. That is a case in which the density diminishes upwards, and the ray has its concavity presented downwards. Then, above the water he placed rectified spirits of wine, when the inverted and erect images were seen below, these appearances continuing many hours and even days, and he carried out similar experiments with water at different temperatures. Everybody knows the experiment with a red-hot poker; the effects of mirage can be seen by looking along the surface of a red-hot poker, held at a distance of about a foot from a sheet of paper, when there is perceptible refraction. Again, Wollaston looked along a horizontal plate of glass upon which he poured ether, and a line appeared instantaneously upon the opposite wall at an elevation of half a degree, this effect being due to the cold caused by the evaporation of the volatile liquid. Finally, Brewster showed that all the phenomena of unusual refraction might be observed by holding a heated iron over a mass of water bounded by parallel plates of glass, and then substituting a cold body for the hot iron.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE foundation-stone of the Gordon Memorial College at Khartoum was laid on Thursday last by Lord Cromer, who remarked that the College would aim at diffusing knowledge of agriculture, engineering, and other practical acquirements useful to all classes.

THE New South Wales Government invite applications for the position of Professor of Physics in the University of Sydney, from University graduates under thirty-five years of age. Particulars of the conditions of appointment, duties, &c., can be obtained from Sir Daniel Cooper, Bart., G.C.M.G., Acting Agent-General for New South Wales, 9, Victoria Street, Westminster, London, S.W.

THE necessity of encouraging scientific investigation, and of providing means for training investigators, is pointed out by Prof. Cleveland Abbe in the U.S. *Monthly Weather Review* (September 1898). He remarks:—"A mistaken idea has widely prevailed that the investigator is a genius, born and not made. The history of German science has, however, shown that environment and training are as important as birth and inheritance. The whole system of education in the German universities has for five generations been directed to the development of the investigator as its highest product. Those who discover important new facts, laws, or principles have been rewarded with the highest places in the intellectual world of that nation. Those who feel that they have a desire or calling for scientific research are encouraged to study for the degree of doctor of philosophy, a degree that is only granted when the candidate has, by actual observation, experiment, or exploration, made some important contribution to human knowledge. The professors under whom he studies have, in their turn, made many similar contributions, and are well prepared to judge of the value of his work. The German universities have, during the past seventy years, published over fifty thousand so-called "doctors' dissertations," embodying the results of the works of fifty thousand candidates. The consequence is that to-day Germany easily leads all the world in the amount and value of her contributions to human knowledge and the energy with which her students pursue the study of nature.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, December 1898.—At the October meeting of the Society seven papers were communicated. Abstracts of the papers not to be published in the *Bulletin* are given.—Prof. Woodward's paper, on