

is probable, Mr. Burnham's remeasurements after eleven years indicating relative fixity, notwithstanding Aldebaran's appreciable advance in the meantime. A more remote companion, however, discovered by Herschel in 1781, is certainly optical, and has been shown at Lick to be double (*ibid.*, No. 2875). Most likely it forms part of the cluster of the Hyades, upon which Aldebaran is casually projected.

The division of the leading member of the group known as  $\sigma$  Orionis illustrates Struve's remark that multiple stars are intermediate between double stars and clusters. Herschel saw it as doubly triple, one set being much fainter than the other. Each proved, under Struve's and Barlow's scrutiny, quadruple, with two very small stars between; while the chief of the decuple assemblage has been resolved at Lick into an excessively close pair, recalling the case of Sir J. Herschel's quintuple star 45 Leporis, broken up into *nine* components by Burnham in 1874. No relative, and scarcely any absolute motion is perceptible among the constituents of  $\sigma$  Orionis; but one of them, called "ashen" by Struve, "grape-red" by Webb, is perhaps variable in colour.

The "Pointer" next the Pole,  $\alpha$  Ursæ Majoris, has so far been seen as double only with the giant telescope of Mount Hamilton. The extreme difficulty of the pair arises from the disparity of light between its members, the eleventh magnitude satellite at  $0''.83$  being almost swallowed up in the glare of its brilliant primary. This disparity, too, throws some shadow of doubt on the reality of the connection, since the supply of small stars for the occupation of chance positions is of course vastly greater than of large. The similar, but more distant companion of  $\gamma$  Cassiopeiæ (at  $2''.18$ ) also recently discovered at Lick, is hence not unlikely to prove merely optical, the Milky Way, in which this pair occurs, being pre-eminently rich in such objects; and the presumption is still smaller that a fourteenth magnitude neighbour of  $\theta$  Cygni owns a genuine allegiance. But here, as Mr. Burnham points out, the proper motion of the larger star will speedily decide (*Astr. Nach.*, No. 2912.) There can, on the other hand, be no hesitation in admitting that  $\eta$  Ophiuchi, resolved last spring by the same indefatigable observer into two nearly equal components, at  $0''.35$ , constitutes a physical system, and one in which rapid movements may be looked for. The stars evidently travel together, else they should have been, through the effects of a proper motion of one second of arc in ten years, so far apart a little time back that they could not possibly have escaped separate discernment. Their relation to the Milky Way is picturesque, and has been thought to be significant. "Situated at the extreme northern and pointed extremity of a luminous elongated patch of milky light," Mr. Gore remarks,  $\eta$  Ophiuchi "looks as if it were drawing the nebulous matter after it like the tail of a comet" (*Journal Liverpool Astr. Society*, vol. vii. p. 178). But we may safely regard the appearance as illusory.

Some of Mr. Burnham's measures of known doubles also supply results of interest. Thus, the duplex, sea-green companion of  $\gamma$  Andromedæ can now barely be "elongated" with a magnifying power of 2700 on the great refractor. Yet, so lately as 1581, the two stars could be distinguished with eight inches of aperture. The unequal pair, 99 Herculis, discovered by Alvan Clark in 1859, is even more recalcitrant. No amount of optical constraint can now extract from it the slightest indication of duplicity. Since 1878, 85 Pegasi has traversed  $213^\circ$  of its orbit; and Mr. Schaeberle's new elements, embodying the Lick data, give it a period of  $22\frac{1}{3}$  years, and oblige us (on the dubious assumption that Brünnow's small parallax can be depended upon) to ascribe a mass to the system eleven times the solar, the components revolving at nearly eighteen times the distance of the earth from the sun. The sun and Jupiter, if of equal areal lustre, would present, at half the supposed distance of 85 Pegasi, just its telescopic aspect.

Like 85 Pegasi,  $\delta$  Equulei is optically triple, while physically double, the companionship of Struve's more distant attendant being in each case temporary and accidental. The bright star of  $\delta$  Equulei was divided by O. Struve in 1852, and the pair soon proved to be in exceptionally rapid motion. They constitute, in fact, the swiftest binary system yet known. Glasenapp's period, nevertheless, of  $11\frac{1}{2}$  years is evidently too short. The Lick measures show the star to be lagging slightly behind its predicted place.

The investigation of stellar orbits has scarcely yet emerged from a tentative stage. Its results are for the most part loose approximations, largely open to future correction. There are very few stars of which the period is known within a few years; there are perhaps two—42 Comæ and  $\xi$  Ursæ—of which it is known within a few months. This is due to no lack of skill or diligence in the computers, but solely to the deficiencies, both in quality and quantity, of the materials at their command. Very small errors become enormous when they affect the relative situations of objects divided by a mere *hair-breadth* of sky; and there is no branch of astronomy in which "personality" has played a more conspicuous or a more vexatious part than in double-star measurements. This at least is abolished by photography; which has, however, as yet proved applicable only to a limited class of coupled stars. With the extension of its powers to all, a new era in the knowledge of stellar revolutions may be expected to open.

A. M. CLERKE.

#### GEOLOGICAL EXCURSION TO THE ACTIVE AND EXTINCT VOLCANOES OF SOUTHERN ITALY.

THE excursion of geologists to the volcanic regions of South Italy came to a very satisfactory conclusion. We have already referred to the first part of the excursion to the Lipari Islands, and the interesting state of activity in which the volcanoes of Vulcano and Stromboli were found to be in. On leaving those islands the party proceeded to examine the Val di Bove, the Cyclopean Islands, the slopes of Etna with its numerous parasitic cones and lava streams, and the central crater itself. The Italian Minister of Public Instruction allowed the party to sleep in the observatory near the mountain summit, and although the weather was rough and misty, about half the party were able to get a good view of the crater, which is now in a solfataric condition. The geologists had also the advantage of becoming acquainted with the mud volcanoes of Paterno. In this part of the excursion the party had the valuable help of Prof. O. Silvestri, to whom Dr. Johnston-Lavis handed over the direction at Etna, although still acting as general director and interpreting Prof. Silvestri's demonstrations. All along the journey the party were *jeté*d by the prefect of the province and the mayors of the different communes, and found invaluable hospitality in the splendid villa of the Marquis Favara at Biancavilla. The second fortnight of the excursion was spent at Naples and its vicinity, under the direction of Dr. Johnston-Lavis, aided for the sedimentary rocks by Prof. Bassani of the University of Naples. Although the weather was not so favourable as in Sicily, the delay only amounted to two days. Many thanks are due to the mayor of Naples for his hospitality in providing for the party a splendid steam yacht for their visit to Capri and Ischia, so affording very greatly increased facilities for their excursions. The members gave a day to the examination of the reservoirs and other works connected with the new and most perfect and purest town water supply in Europe, as well as the new drainage works and destruction of the old town of Naples. Although the visit to the crater of Vesuvius had to be delayed for upwards of ten days for suitable weather,

the party had the good fortune to see the volcano in great perfection. There existed at the time of the visit four concentric crater rings and two main vents ejecting red-hot lava cakes, which the geologists were able to approach within ten yards, after which they descended some distance on the slopes of the great cone to a small lava stream issuing from its sides, at which various experiments were performed. The director, who has visited the crater over sixty times, remarked that he had never but once seen it to greater perfection.

The numerous volcanoes of the Phlegrean fields were examined, and most of those present expressed their satisfaction at the many important lessons to be learnt from them. At Pompeii the members had the valuable direction of Dr. A. Sambon for the archaeological part, whilst Dr. Johnston-Lavis devoted himself only to explaining the phenomena and materials associated with the destruction of the buried cities.

After Naples the party examined on their way northwards the volcano of Roccamonfina, under the direction of Dr. Johnston-Lavis, and Monte Cassino under that of Prof. Bassani of Naples. The Lyceum at Sessa Aurunca was kindly lent by the commune to accommodate the members during their night's stay on their way over the mountain, a sumptuous dinner being provided by the municipality. The carriages the next day were offered by the province of Terra di Lavoro, and after the ascent had been made of the central cone (Mount Santa Croce) a lunch not less sumptuous than the dinner of the preceding evening was given by the town of Roccamonfina.

The next day was devoted to Monte Cassino, its manuscript and art treasures, as well as the Cretaceous limestones constituting the mountain upon which it is built. Prof. Bassani acted as geological director.

At Rome the party examined the concentric craters, parasitic cones, crater lakes, lava streams of the Alban volcano, also the fossiliferous Pliocene beds capped by volcanic deposits close to the Eternal City. The lower Mesozoic limestones, the travertine, the sulphur springs, and all the other points of geological interest of the Campagna Romana were visited.

As directors of the excursions around Rome may be mentioned Profs. Mele, Portis, and Strüver. Signor Zezi (secretary of the Italian Geological Survey), Signors Demarchi, Clerici, Tellini, and Prof. Lanciani kindly undertook the archaeological demonstrations which acted as dessert to the rich geological repast.

The official excursions terminated on October 28, with the trip to Tivoli, although a number of geologists remained to visit the sights of Rome. In the evening a dinner was offered to Dr. Johnston-Lavis, Mr. L. Sambon, and the Roman directors. The thanks of the party were offered to the Minister of Public Instruction, Prefects and Mayors, and private individuals, who had done so much to facilitate the progress, through often almost inaccessible districts, for a large party.

Special votes of thanks were proposed to the different Italian geologists who had kindly offered their services in directing the party through their districts, and lastly to Dr. Johnston-Lavis for originating this new departure in scientific excursions, as well as acting not only as director in his own districts, but interpreting and organizing during the whole excursion, and to Mr. L. Sambon for his administrative skill, his attainments in different branches of science, which added so much to the success and comfort of over forty English geologists, not to speak of the numerous Italians who from time to time joined.

#### REMARKABLE HAILSTONES.

ON p. 43 of the present volume of NATURE the following extract is given from a paper by Prof. Houston in the Journal of the Franklin Institute:—"On some of the hailstones, though not on the majority of them, well-

marked crystals of clear transparent ice projected from their outer surfaces for distances ranging from  $\frac{1}{8}$  to  $\frac{1}{4}$  of an inch. These crystals, as well as I could observe from

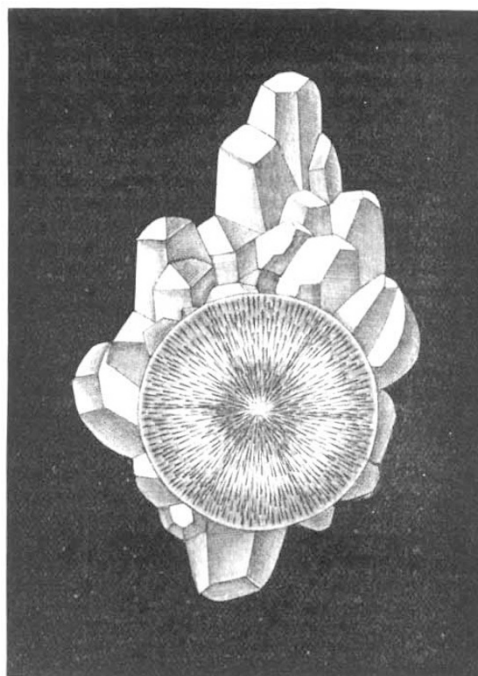


FIG. 1.

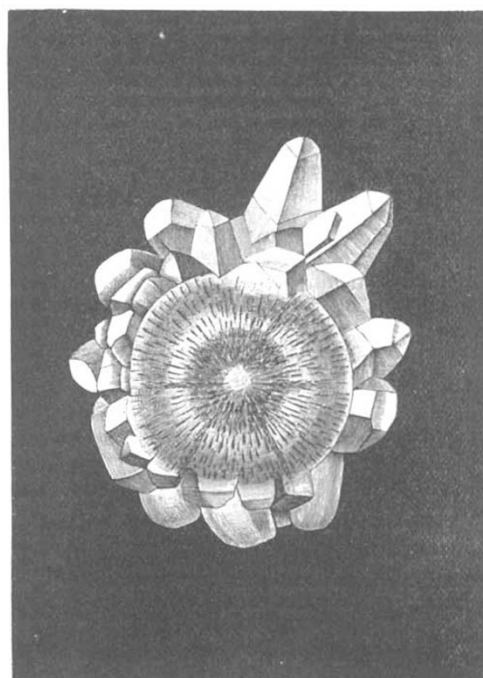


FIG. 2.

the evanescent nature of the material, were hexagonal prisms with clearly cut terminal facets. They resembled the projecting crystals that form so common a lining in