

which were certainly employed by Arabian astronomers, and very probably also by the Greeks and Romans, may indeed, in some degree, have increased the exactness of the observations by causing the object to be seen through diopters or slits. Abul-Hassan speaks very distinctly of tubes, to the extremities of which ocular and object diopters were attached; and instruments so constructed were used in the observatory founded by Hulagu at Meragha. If stars be more easily discovered during twilight by means of tubes, and if a star be sooner revealed to the naked eye through a tube than without it, the reason lies, as Arago has already observed, in the circumstance that the tube conceals a great portion of the disturbing light (*rayons perturbateurs*) diffused in the atmospheric strata between the star and the eye applied to the tube. In like manner, the tube prevents the lateral impression of the faint light which the particles of air receive at night from all the other stars in the firmament. The intensity of the image and the size of the star are apparently augmented. In a frequently emendated and much contested passage of Strabo, in which mention is made of looking through tubes, this "enlarged form of the stars" is expressly mentioned, and is erroneously ascribed to refraction.\*

\* The passage in which Strabo (lib. iii., p. 138, Casaub.) attempts to refute the views of Posidonius is given as follows, according to the manuscripts: "The image of the sun is enlarged on the seas at its rising as well as at its setting, because at these times a larger mass of exhalations rises from the humid element; and the eye, looking through these exhalations, sees images refracted into larger forms, as observed through tubes. The same thing happens when the setting sun or moon is seen through a dry and thin cloud, when those bodies likewise appear reddish." This passage has recently been pronounced corrupt (see Kramer, in *Strabonis Geogr.*, 1844, vol. i., p. 211), and *δι ὑάλων* (through glass spheres) substituted for *δι ἀυλῶν* (Schneider, *Eclog. Phys.*, vol. ii., p. 273). The magnifying power of hollow glass spheres, filled with water (Seneca, i., 6), was, indeed, as familiar to the ancients as the action of burning-glasses or crystals (Aristoph., *Nub.*, v. 765), and that of Nero's emerald (Plin., xxxvii., 5); but these spheres most assuredly could not have been employed as astronomical measuring instruments. (Compare *Cosmos*, vol. ii., p. 245, and note †.) Solar altitudes, taken through thin, light clouds, or through volcanic vapors, exhibit no trace of the influence of refraction. (Humboldt, *Recueil d'Observ. Astr.*, vol. i., p. 123.) Colonel Baeyer observed no angular deviation in the heliotope light on the passage of streaks of mist, or even from artificially developed vapors, and therefore fully confirms Arago's experiments. Peters, at Pulkowa, in no case found a difference of  $0''\cdot017$  on comparing groups of stellar altitudes, measured in a clear sky, and through light clouds. See his *Recherches sur la Parallaxe des Etoiles*, 1848, p. 80, 140-143; also Struve's *Etudes Stellaires*, p. 98. On the application of tubes for astronomical observation in Arabian instruments, see Jour-