Bright Stars and Wide Whorls

Plato's *Republic* culminates in a model of the cosmos based on a spindle, with eight nested hemispheres ("whorls") representing the moon, sun, planets, and fixed stars (10, 616E). Plato describes the whorls as differing in width, and color, and speed. The model is evidently qualitative, not precise, but the colors and speeds correspond accurately to what Plato and his contemporaries would have observed.

The widths of the whorls then ought also to correspond to some visual feature of the heavenly bodies observed by Plato and his contemporaries. I argue that the widths represent the range of brightness differences as perceived among the fixed stars, or respectively, the range of brightness variations as perceived for each planet. That is, the widths in the received text of Plato's *Republic* represent the differences in apogee and perigee, just as Proclus says (Kroll 1901, 217; Siorvanes 1996, 281, and cf. 279–282, 293–301). The same explanation is also given by Dercyllides, *On the Spindle and Whorls in Plato's Republic*, as quoted by Theon of Smyrna, book III (Hiller 1878, 201).

Craigie, in Jowett & Campbell (1894) 476, proposed that the widths encoded the distances between the orbits ("the distance of each planet from the other"), and that each planet was at the outer edge of its whorl. No account, however, has been found for the specific set of distances. Most subsequent scholars who address the issue have followed that line, e.g.: Adam (1902) 449–450, 472–475; Cornford (1951) 345; and Gregory (2000) 125. Nevertheless, Dicks (1970) 113 rejects distance as the explanation, stating that there is "no discernible correlation between the order assigned to the breadths and any astronomical facts."

Indeed, Dicks rightly objects, and the orbital distance of a planet was not an observable quantity in Plato's era. Only the periods, i.e., speeds, of the planets, plus their brightness and

color, were observable. Any model that included brightness could be accommodated to any set of hypothetical distances by using a suitable set of hypothetical intrinsic brightnesses. (We should not evaluate or interpret ancient astronomical models with regard to how they address modern questions, but rather with regard to how they address ancient questions.)

On the other hand, ancient observers were very well aware of brightness differences between stars, *contra* Bowen (2013) 288–294 (whose arguments against imputing retrograde motion to early Greek astronomers are stronger, and more central to his overall project). There is copious pictorial and written evidence from the archaic and classical periods showing that Greeks paid attention to differences in brightness of the fixed stars, and particularly among them Arcturus and Sirius. Moreover, the existence of constellations *ipso facto* requires that the people who define and recognize them are perceiving some fixed stars as brighter than others. So, the passages in epic and elsewhere that refer to the Bear, Boötes, Orion, the Pleiades, or the Hyades, *ipso facto* demonstrate that the Greeks regarded the stars comprising each of those constellations as relatively brighter than other nearby stars.

Greeks of the archaic and classical periods also regarded at least some of the planets as notably bright: the "Morning Star," later understood to have been either of the two planets Venus and Mercury. Moreover, some Greeks attributed changes in brightness to mutable stars, or at least to some of them. Democritus, Anaxagoras, and other early theorists of comets regarded them as starlike but mutable, in position, shape, and brightness: Wilson (2008). Other issues, such as the illusion that the sun and moon were nearer when setting or rising, and an alternate text for 616E (the widths of the whorls) that Proclus reports (Kroll 1901, 218–220; Adam 1902, 475–476), augment and enrich the picture.

Astronomers up to the time of Plato were able to observe brightness variations in mutable stars, although they would not have had the means to measure such variations precisely. Nevertheless, the widths of the planetary whorls correspond well to brightness variations of the respective stars, as known in modern times. As he did for the colors and the speeds of the whorls, Plato has recorded in the widths of the whorls an accurate if partial model of the brightness variations of the fixed and mutable stars.

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