Reactie van David Dunham (IOTA)

I read with interest the recent post by David Dickinson, 'How Astronomers Used Asteroids to Measure Stars', at https://www.skyandtelescope.com/astronomy-news/how-astronomers-used-asteroids-measure-stars/ ….

I heard of this work earlier at https://www.sciencedaily.com/releases/2019/04/190415113825.htm and was able to download their paper from ResearchGate. I've been in communication since with the main person in their project, Michael Daniels. I pointed out to him that on at least two previous occasions, IOTA had measured the angular diameters of stars from asteroidal occultations; I copy the information about that, that I sent to Dr. Daniels, below. IOTA observers also recorded the occultation on 2018 May 22 that VERITAS observed, and at least one of our recordings shows the Fresnel diffraction pattern ' we're working with Dr. Daniels to see if it might be of use in their work. The IOTA observations of that event were in the area south of Phoenix and covered only the northern part of Penelope, so adding the VERITAS observation near the southern limit of the occultation will help with determining the shape of the asteroid. Unfortunately, the VERITAS observations were not precisely timed to UTC. The results of the IOTA observations can be found by scrolling down to 2018 May 22 on IOTA's results page for 2018 at http://www.asteroidoccultation.com/observations/Results/Reviewed/index2018.html but we expect to retract the claim of very close duplicity noted there; that was more likely due to the resolved Fresnel diffraction effects.

David Dickinson also wrote:
'Astronomers have also used a diffraction method during lunar occultations, but it only works for stellar diameters down to about 1 milliarcsecond. Only 17 stars have a measured angular diameter greater than this, and of those, only Antares lies along the current path of the Moon.'

The first sentence above is true, but the rest is not. Several stars have had their angular diameters measured from lunar occultations, including Aldebaran (very noticeable fades visible to the naked eye with its angular diameter of about 18 mas) during the series of occultations that concluded last year. In the 1970's, I worked with David Evans' team at the University of Texas that measured the angular diameters of other stars using high-speed photoelectric recordings of lunar occultations, including upsilon Capricorni, mu Geminorum, TX Piscium, and R Leonis, among others. The technique continues to be used today, mainly with observations in the IR, coordinated by Andrea Richichi and Octavi Fors, to whom I am copying this. Even in 1987, there had been 348 lunar occultation measurements of the angular diameters of 124 stars; see N. White et al., Astronomical Journal, Vol. 94, p. 751, 'A Catalog of Stellar Angular Diameters Measured by Lunar Occultation'. The '17 stars' noted by Dickinson only applies to stars whose disks have been directly resolved, from the Wikipedia link https://en.wikipedia.org/wiki/List_of_stars_with_resolved_images . As noted above, many more stellar diameters have been measured with lunar occultations, but they only give a one-dimensional 'cut' across the star, and assumptions need to be made about the limb darkening of the star when determining its diameter from the data.

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But it's true, asteroidal occultations can measure significantly smaller angular diameters than is possible with lunar occultations. About them, I wrote to Dr. Daniels:

Although certainly not as well as you have, on two occasions, we in the International Occultation Timing Association have also measured the angular diameters of stars from asteroidal occultations, but these were stars whose angular diameters were much larger than the Fresnel diffraction scale. The first was of the 5.7-mag. red giant star LQ Aquarii that was occulted by the binary asteroid (90) Antiope on 2011 July 19 . An analysis by David Herald found the star's diameter to be 2.1 +/-0.1 mas, published in his article, 'Learning from two recent asteroidal occultations' in Journal for Occultation Astronomy (JOA) 2012, No. 3, pages 3-9 (the diameter result is near the top of p. 6). That article mentions the occultation of a larger star, 2 nd -mag. delta Ophiuchi by the asteroid Roma; in that case, the star was about 1/3 rd the angular size of the asteroid and, with that and the wide variety of observation types that were made, we have not been able to disentangle the irregular shape and size of the asteroid, from the star's disk, in the recorded light curves. The JOA's are now all available free online in the publications part of our Web site occultations.org (thanks for mentioning that in your paper). The (90) Antiope occultation was also published in a paper, 'Shape and Size of (90) Antiope derived from an Exceptional Stellar Occultation on July 19 2011' by F. Colas et al. in proceedings of the Asteroids, Comets, and Meteors conference, Niigata, Japan (also, Lunar Planetary Institute Contribution No. 1667, id. 6427), May 2012; it gives a preliminary size of LQ Aquarii, but D. Herald's analysis given in JOA was much more thorough, resulting in smaller error bars.

Also, an 8th-mag. star was occulted by both components of (617) Patroclus on 2013 Oct. 21 ; the results were published in the Astronomical Journal, Vol. 149, No. 3, p. 113, 2015. However, although gradual events due to the star's angular diameter were evident in many of the recordings, the AJ article does not give the measured diameter. Dave Herald did an analysis of the observations for the star's angular diameter, like he did for LQ Aquarii by (90) Antiope, but I don't think that result was published; I attach only the plots of the fits to the observations that Herald made, in the attached file 'Patroclus_star_diameter_DH.png'.

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First Observed Asteroidal Occultation'

Dickinson mentions that the first observed asteroidal occultation was one by (3) Juno in 1958, but we now know, with a much better Juno ephemeris and Hipparcos/Gaia data for that star, that the 1958 observation was surely erroneous, as the shadow of Juno cast by the star passed more than 1000 km from the observer's location that night. It was a difficult visual observation, as Juno was slightly brighter than the target star. Now, we are confident that the first-observed asteroidal occultation was one by (2) Pallas observed photoelectrically in India in 1961; David Herald published an article about this in Journal of Occultation Astronomy, issue 2014_4, pages 9-12, available at http://www.iota-es.de/JOA/JOA2014_4.pdf .