Freeth T (2014) Eclipse Prediction on the Ancient Greek Astronomical Calculating Machine Known as the Antikythera Mechanism. PLoS ONE 9(7): e103275.

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Following improved scanning in 2005 of the surviving fragments of the Antikythera Mechanism, as well as extensive epigraphic study, Dr, Tony Freeth presents a new interpretation of the device, particularly its back plate. This article outlines two mathematical models, the Eclipse Year Model (EYM) and Zig-Zag Model (ZZM), created to help solve the so-called "Saros Dial" of the Antikythera Mechanism—the dial responsible for predicting both solar and lunar eclipses.

Key Points:

1. A data gathering campaign in 2005 employed two new techniques to explore the Antikythera Mechanism, which in turn unlock several significant discoveries.
    a. Polynomial Texture Mapping (PTM), aka Reflectance Transformation Imaging (RTI) allows for improved surface visibility for viewing inscriptions in fine detail.
    b. Microfocus X-ray Computer Tomography (X-ray CT) allows for high resolution 3D x-rays in "slices" which allow internal gearing to be viewed. This process also leads to the discovery of several thousand additional characters.
2. The data from 2005 reinforces the idea that the Antikythera Mechanism is a complex astronomical calculating machine based on a combination of ancient Babylonian and Greek mathematical astronomy.
3. On the back of the device are two dials.
    a. The 19-Year Metonic cycle calendar dial at the top.
    b. The 223-Month Saros cycle Eclipse Prediction dial at the bottom (focus of the article).
4. In fragments A, E, and F of the device (all from the Saros dial), are a significant number of Greek characters which outline type of eclipse (solar or lunar), hour of eclipse, and a glyph index which references a description of said eclipse.
5. To complete the glyph distribution, Freeth utilizes an arithmetic model based on the astronomical ideas of closeness to note (the point where the moon crosses the nodes of the ecliptic, the plane of the suns orbit around the earth in geocentric astronomy) and the asymmetry of observability of solar eclipses due to parallax.
    a. Freeth also divides the 223 lunar months and 19 eclipse years of the Saros period in ***Eclipse Year Units (EYu)*** so that each eclipse year lines up precisely below the preceding year. (1 Lunar Month = 38 EYU = 0.78 Days)
    b. Freeth calls this the ***Eclipse Year Model***, and it maps glyphs representing syzygies onto eclipse years. This model is defined entirely using integers.
    c. The output also suggests further unrepresented index glyphs for both solar and lunar eclipses.
6. The glyphs on the Antikythera Mechanism also include an hour-accurate prediction of eclipse time.
    a. Based on Babylonian System B, Freeth developed a model he refers to as the ***ZigZag Model*** **(ZZM)** which uses linear zigzag functions with the following parameters:
        i. Fixed parameters tied to astronomy (min, mean, and max lunar month length; period of synodic and anomalistic months, solar year) provide the minima and maxima.
        ii. Free parameters in the form of the phases of lunar and solar anomalies at FM_1 and the input times of FM_1 and NM1. These can be altered to optimize the ZZM.
7. These two models, in tandem, constrain the date of FM_1 to May 12, 204 BCE. Interestingly, this is a date proposed in 2013 by another group using conflicting methods. Recent epigraphic analysis is consistent with this date (though this analysis sharply departs from previous analyses).
    a. Freeth urges caution since ZZM is admittedly not an exact model, and is likely to undergo further modification. Additionally, the date of the device itself does not necessarily match the date of the dial's design. Still, all factors point to Epiros, Greece, as a good geographic match.