## The Approach, *Almagest* X.7 (H.I.2.321)

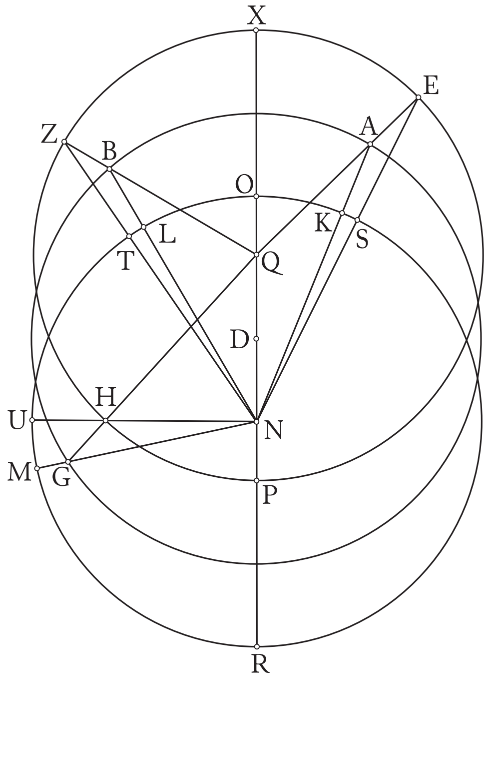
ὥσπερ οὖν ἐπὶ τῆς σελήνης λαβόντες τριῶν πανσεληνιακῶν ἐκλείψεων τούς τε τόπους καὶ τοὺς χρόνους ἀπεδείκνυμεν διὰ τῶν γραμμῶν τόν τε τῆς ἀνωμαλίας λόγον καὶ τὸν τοῦ ἀπογείου τόπον, τὸν αὐτὸν τρόπον καὶ ἐνταῦθα τριῶν ἀκρωνύκτων τῶν πρὸς τὴν μέσην τοῦ ἡλίου πάροδον διαμέτρων καθ' ἕκαστον τῶν ἀστέρων τούτων τούς τε τόπους τηρήσαντες ὡς ἔνι μάλιστα ἀκριβῶς διὰ τῶν ἀστρολάβων ὀργάνων καὶ ἀπὸ τῶν κατὰ τὰς τηρήσεις μέσων τοῦ ἡλίου παρόδων τὸν πρὸς τὸ λεπτομερέστερον τῆς διαστάσεως χρόνον τε καὶ τόπον προσεπιλογισάμενοι ἀπὸ τούτων δείκνυμεν τόν τε τῆς ἐκκεντρότητος λόγον καὶ τὸ ἀπόγειον.

Just as in the case of the moon, having taken three lunar eclipses, we demonstrated trigonometrically the ratio of the irregularity and the position of the apogee, in the same way here too, from three acronychal oppositions according the mean course of the sun, for each of these bodies, having observed as accurately as possible by means of astrolabic instruments, and from the mean courses of the sun at the observations, further calculating to more precision the time and the position of the separation, we demonstrate from these the ratio of eccentricity and the apogee.

## The Plan, *Almagest* X.7 (H.I.2.324)

γεγράφθωσαν δὴ ἐν τῷ τοῦ ζῳδιακοῦ ἐπιπέδῳ γ̅ ἴσοι κύκλοι, ὧν ὁ μὲν τὸ κέντρον φέρων τοῦ ἐπικύκλου τοῦ τοῦ Ἄρεως ἔστω ὁ ΑΒΓ περὶ κέντρον τὸ Δ, ὁ δὲ τῆς ὁμαλῆς κινήσεως ἔκκεντρος ὁ ΕΖΗ περὶ κέντρον τὸ Θ, ὁ δὲ ὁμόκεντρος τῷ ζῳδιακῷ ὁ ΚΛΜ περὶ κέντρον τὸ Ν, ἡ δὲ διὰ πάντων τῶν κέντρων διάμετρος ἡ ΞΟΠΡ· ὑποκείσθω δὲ τὸ μὲν Α, καθ' οὗ ἦν τὸ τοῦ ἐπικύκλου κέντρον ἐν τῇ α′ ἀκρωνύκτῳ, τὸ δὲ Β, καθ' οὗ ἦν ἐν τῇ β′ ἀκρωνύκτῳ, τὸ δὲ Γ, καθ' οὗ ἦν ἐν τῇ γ′ ἀκρωνύκτῳ, καὶ ἐπεζεύχθωσαν αἵ τε ΘΑΕ καὶ ΘΒΖ καὶ ΘΗΓ καὶ ΝΚΑ καὶ ΝΛΒ καὶ ΝΓΜ, ὥστε τὴν μὲν ΕΖ τοῦ ἐκκέντρου περιφέρειαν μοιρῶν εἶναι τῶν τῆς α′ περιοδικῆς διαστάσεως π̅α̅ μ̅δ̅, τὴν δὲ ΖΗ τῶν τῆς β′ ϟ̅ε̅ κ̅η̅, καὶ πάλιν τὴν μὲν ΚΛ περιφέρειαν τοῦ ζῳδιακοῦ τῶν τῆς φαινομένης α′ διαστάσεως μοιρῶν ξ̅ζ̅ ν̅, τὴν δὲ ΛΜ τῶν τῆς β′ ϟ̅γ̅ μ̅δ̅.

εἰ μὲν οὖν αἱ ΕΖ καὶ ΖΗ τοῦ ἐκκέντρου περιφέρειαι ὑπὸ τῶν ΚΛ καὶ ΛΜ τοῦ ζῳδιακοῦ περιφερειῶν ὑπετείνοντο, οὐδὲν ἂν ἄλλο πρὸς τὴν δεῖξιν ἔτι τῆς ἐκκεντρότητος ἐζητοῦμεν· ἐπεὶ δ' αὐταὶ μὲν τὰς ΑΒ καὶ ΒΓ τοῦ μέσου ἐκκέντρου ὑποτείνουσι μὴ δεδομένας, ἐὰν δ' ἐπιζεύξωμεν τὰς ΝΣΕ καὶ ΝΤΖ καὶ ΝΗΥ, πάλιν τὰς ΕΖ καὶ ΖΗ τοῦ ἐκκέντρου περιφερείας αἱ ΣΤ καὶ ΤΥ τοῦ ζῳδιακοῦ ὑποτείνουσι μηδὲ αὐταὶ δηλονότι δεδομέναι, δεήσει πρότερα δοθῆναι τὰ ΚΣ καὶ ΛΤ καὶ ΜΥ διάφορα τμήματα, ἵνα ἀπὸ τῶν συζυγουσῶν περιφερειῶν τῶν τε ΕΖΗ καὶ τῶν ΣΤΥ πρὸς ἀκρίβειαν ὁ τῆς ἐκκεντρότητος λόγος ἀποδειχθῇ. ἐπεὶ δ' οὐδὲ ταύτας οἷόν τέ ἐστιν ἀκριβῶς λαβεῖν πρότερον τοῦ τε τῆς ἐκκεντρότητος λόγου καὶ τοῦ ἀπογείου, δοθήσονται μέντοι ἔγγιστα, κἂν μὴ ἀκριβῶς ἐκεῖνα προυπαρχθῇ, διὰ τὸ μὴ μεγάλας αὐτῶν γίγνεσθαι τὰς διαφοράς, ποιησόμεθα πρότερον τὸν ἐπιλογισμὸν ὡς μηδενὶ ἀξιολόγῳ διαφερουσῶν παρὰ τὰς ΚΛΜ, ΣΤΥ περιφερειῶν.

Let 3 equal circles have been produced in the plane of the ecliptic, of which let that carrying the epicycle of Mars be *ABG* about center *D*, let the eccenter of regular motion be *EZH* about center *Q*, let the [circle] concentric with the ecliptic be *KLM* about center *N*, and let the diameter through all three centers be *XOPR*. Let point *A* be assumed at which was the center of the epicycle for the 1st acronychal opposition, *B* at which it was at the 2nd acronychal opposition, and *G* at which it was at the 3rd acronychal opposition. Let *QAE*, *QBZ*, *QHG*, *NKA*, *NLB*, *NGM* have been joined, such that arc *EZ* of the 1st interval of motion is 81 44 degrees, and arc *ZH* of the 2nd is 95 28. Furthermore, arc *KL* of the ecliptic is 67 50 degrees of the first interval of the apparent [motion], and arc *LM* is 93 44 of the second.

Now, if *EZ*, *ZH* of the eccenter subtended *KL*, *LM* of the ecliptic, we would want nothing else for the proof of the eccentricity, but since they are subtended by *AB*, *BG* of the middle eccenter, which are not given, and if we join *NSE*, *NTZ*, *NHU*, again *ST*, *TU*, themselves clearly not given, subtend arcs *EZ*, *ZH* of the eccenter. In order that the ratio of eccentricity be accurately proven from the corresponding arcs *EZ*, *ZH*, and *ST*, *TU*, the differences cut off, *KS*, *LT* and *MY* must first be given. Since, however, how much they are is not grasped accurately before the ratio of eccentricity and the apogee, nevertheless, they will be given nearly, even if each has not been carried through accurately, because their differences will not be large. We will first make the calculation as if the deviations of arcs *ST*, *TU* compared to arcs *KL*, *LM*, were not important.