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Aratus' *Phaenomena* beyond Its Sources

by

Stamatina Mastorakou

Interpretatio: Series A 3

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Contents

Editors' Foreword 7

Abstract 9

1. Introduction 1

2. Aratus' and Eudoxus' *Phaenomena* 2
   2.1 A few words on Hipparchus' commentary 2
   2.2 Comparing the style of Aratus' and Eudoxus' *Phaenomena* 4
      ⋆ The Cepheus-group 4
      ⋆ The Cynosura-group 6
3. Comparing the content of Aratus' and Eudoxus' *Phaenomena* . . . 8
   3.1 The celestial circles 9
   3.2 The Tropic of Cancer 9
4. Conclusion 12

Bibliography 15

Editors' Foreword

01 May 2019

In late 2014, we decided that it was time to re-invent *Interpretatio*. We started from its original focus as a series of publications devoted to the history of premodern science understood as a subject that includes what was variously called science from antiquity up to the early modern period in cultures ranging from Spain to India, and from Africa to northern Europe. But this time, we resolved to emphasize the need to contextualize our subject, that is, to analyze the workings of the diverse contexts in which this premodern science figured at any given point in time and in the face of which it took its form and direction.

Our broad aim, as before, is to make fundamental texts in the history of science accessible to the modern reader in publications that satisfy the requirements of specialists but still address the needs of non-specialists and general readers. To accomplish this, however, we have chosen to focus primarily (but not exclusively) on editions, translations, and interpretations. Moreover, in order to capture scholarly endeavor of this sort in all the usual formats, we have divided *Interpretatio* into two series. Series A will publish items of fewer than 100 pages in length; Series B is for longer items and will include monographs, collections of essays, and so forth.

Series A is admittedly an experiment: not only will it exist solely online—we have no plans at this time to issue a printed version, though each item will of course be printable—the articles in Series A will not constitute a traditional journal. Indeed, to take full advantage of the freedom of online publication, the items in *Interpretatio* A will be numbered sequentially and presented independently. In effect, items in Series A will be a series of booklets while those in Series B, which will exist both online and in print, will be a series of books.

We are very excited about this venture and would be delighted to learn your thoughts on the items published in *Interpretatio* as well as on the project in general. You may use the comment box on the page for each item of *Interpretatio* and thus, perhaps, open a more general discussion, or just contact us by email.

But, more importantly, we invite your scholarly contributions to *Interpretatio* and hope that you will give us the opportunity to work with you in advancing the contemporary understanding of premodern science.

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Abstract

In this article, I compare the astronomical poem by Aratus called *Phaenomena* (third century BC) with the citations of a work of the same name by Eudoxus that are found in Hipparchus' only extant work, *In Arati et Eudoxi phaenomena* (second century BC). I argue that, contrary to what most scholars maintain, Aratus' poem is not a mere versification of Eudoxus' work but a version enriched in style, language, *and* content. Indeed, Aratus' *Phaenomena* is a paradigmatic reflection of the astronomical knowledge of the period in which it was written and a comprehensive, non-technical presentation of the celestial phenomena known in his time. It was, as I show, a very popular work, so popular that Hipparchus was moved to correct it in the hope of establishing himself as the authority in astronomy and prose as its proper medium.

Aratus' *Phaenomena* beyond Its Sources

1. Introduction

Aratus' *Phaenomena* is an astronomical poem of the third century BC that remained immensely popular until the Middle Ages. Despite the longevity of the *Phaenomena*, it has taken modern scholars many years to appreciate Aratus' role in the history of literature: only in the last few decades has the *Phaenomena* been roused from its hibernation and put into the bigger picture of Hellenistic poetry. This has in turn involved studying the poem as a representative of the didactic genre[1] and as a product of Stoic influences. It has also been compared to other Hellenistic poems, to the works of Homer and Hesiod, and so forth.[2] Even though scholars have yet to understand the dimensions of the poem's popularity, it seems that they all suppose that Aratus 'neither was nor pretended to be a scientist' [van Noorden 2009, 256] and that he was not an astronomer. Indeed, as Marrou puts it,

> he was essentially a philosopher and a man of letters, one of the wits at the court of Antigonus Gonatas, and all he did was put two prose works into verse and join them together—Eudoxus of Cnidus' *Phaenomena* and Theophrastus' mediocre Περὶ σημείων.…There are errors in his observations: as Hipparchus mentioned in his commentary….
>
> [Marrou 1956, 184: cf. Clarke 1971; Gee 2013, 4]

Marrou's view has indeed become a *topos* and the consensus is that Aratus' poem bears no scientific astronomical value and that it is merely because of the author's poetic skills that both he and the *Phaenomena* became famous throughout the centuries.

Yet, if we take a closer look at this consensus that Aratus' work was merely a copy that Hipparchus evaluates, and so has no real place in our understanding of

---

[1] But see Mastorakou 2019 for an argument that this characterization is misleading, if not incorrect.

[2] Apart from two editions with translation and commentary, Martin 1956 and Kidd 1997, and in addition to the citations in this article, I have found the following selection especially useful: Hunter 1995, Hutchinson 1988, Fakas 2001, and Fantuzzi and Hunter 2004.

Hellenistic astronomy, we will see that it is problematic. In fact, as I will show, Aratus is the liaison between the astronomical knowledge of his time and the general public.[3] Indeed, it is my thesis that to deny or even downplay the poem's astronomical content and its own contribution to celestial knowledge is to strip from it the materials of which it is made and thus to leave our current histories of astronomy incomplete and puzzling.

2. Aratus' and Eudoxus' *Phaenomena*

2.1 *A few words on Hipparchus' commentary*

Eudoxus (408–355 BC) and Hipparchus (*flor.* third quarter, second century BC) hardly need an introduction. The former was a mathematician and an astronomer who, according to Aristotle [*Meta.* Λ.8], proposed a combination of nested revolving spheres to account for the motion of the planets. He also wrote the acclaimed works *Phaenomena* and *Enoptron*.[4] Hipparchus, for his part, took some Greek hypotheses of planetary motion and, by using Babylonian data, specified their parameters in order, it seems, to adapt them for quantitative prediction.[5]

The only extant treatise by Hipparchus, however, is his commentary on Aratus' and Eudoxus' *Phaenomena*. Dicks observes that this work is 'usually dismissed as an early, youthful work of no importance'; but then adds, 'This, however, is hardly correct' [1960, 16–17]. Hipparchus' commentary was written after at least two of his major works, *On Simultaneous Risings* and *On the Rising of the Twelve Signs of the Zodiac*, both of which he mentions. What is more, this commentary, which alone survives, is the one for which Hipparchus gained his reputation outside the small circle of experts in antiquity.

In his commentary, Hipparchus compares Aratus' *Phaenomena* with Eudoxus' *Phaenomena* and *Enoptron* as well as with Attalus' own commentary on Aratus' *Phaenomena*. Hipparchus' goal is to correct the information that these works provide about the heavenly bodies, a goal which requires him to quote numerous lines from Aratus' and Eudoxus' works.[6] Once this comparison is completed,

[3] For a brief history of the *Phaenomena*'s reception, see Possanza 2004, 79–103. On Aratus' place in the history of astronomy and his depictions in art, see Mastorakou 2019.

[4] Hipparchus [*In Arat.* 1.2.2] says that Eudoxus wrote two books, the *Phaenomena* (*Appearances*) and *Enoptron* (*Mirror*), which, he says, were not very different from each other, and that Aratus followed the *Phaenomena* in writing his poem.

[5] For detailed information about Hipparchus' life and works see Dicks 1960, 1–18; Toomer 1978.

[6] For a discussion of Hipparchus' agenda in his preface and in commenting on Aratus, see Mastorakou 2019.

he proceeds to list his own very specific data for the first and last stars to rise and set in each of 42 constellations, along with the degree of the zodiacal circle at the horizon and at the meridian at the moment when each of those stars rises or sets. Finally, he divides the celestial sphere into 24 equinoctial hours and states, beginning at the summer solstice, which stars are separated by one, or very close to one, equinoctial hour.

Hipparchus disregards not only poetry in general but also the poetry in Aratus' composition in particular [*In Arat*. 1.1.7], as well as anything that its commentators write about its poetic character. He recognizes that the poem has been commented on many times before and has consequently been widely discussed by the time that he is writing; and adds, '…but the most careful exposition…is that of Attalus, a mathematical astronomer (μαθηματικός) of our own time' [*In Arat*. 1.1.3].[7] Nevertheless, as Hipparchus sees it, Attalus, one of Aratus' several commentators, makes many mistakes about the heavenly bodies and sometimes even changes things in Aratus' poem that are correct. Still, in Hipparchus' view, Attalus' commentary remains the best, although it is not clear whether it is the best in relation to those by other mathematical astronomers or in relation to those not written by mathematical astronomers. Certainly, as Hipparchus notes, the best astronomers to distinguish which of Aratus' statements were consistent with the actual phenomena and which ones were not are experienced professionals [*In Arat*. 1.1.4]. In that category, Hipparchus distinguishes himself from all the others:

> Eudoxus wrote the same treatise about the phenomena as Aratus but in a more expert way. It is reasonable, then, that [Aratus'] poetry is considered trustworthy from the agreement of so many and such great mathematical astronomers (μαθηματικοί). It is perhaps not fair to blame Aratus even if he happens to stumble in some things, since he wrote the *Phaenomena* following Eudoxus' composition, but without making observations or declaring that he was going forth according to his own mathematical judgement[8] in celestial matters and making mistakes in them.
>
> [Hipparchus, *In Arat*. 1.1.8]

Hipparchus thus puts himself on a level superior to all on the grounds that he can correct previous astronomical views and reveal the truth about the heavens. Below him is Eudoxus, who, although a good mathematical astronomer, is wrong in many instances. After Eudoxus comes Attalus, just a mathematical astronomer, who again is often wrong. Finally, there is Aratus, who is often wrong yet again but whom we should not blame because he is merely a poet trying to follow the work of great mathematical astronomers.

---

[7] All the translations of Hipparchus, *In Arat*. are my own. Translations of Aratus' *Phaenomena* are taken from Kidd 1997.

[8] Manitius 1894, 6.11–12 κατ' ἰδίαν μαθηματικὴν κρίσιν.

It is a great advantage for us to have Hipparchus' commentary in our hands, since this allows us to check for ourselves Hipparchus' claims and to see how Aratus based his poem on Eudoxus' *Phaenomena*, especially since Eudoxus' work has not survived to present times. In what follows, then, I will use Hipparchus' commentary to explore the astronomical knowledge in Aratus' *Phaenomena* and to compare it to that in Eudoxus' work, with the aim of assessing rigorously whether the poem is worthy only for its literary qualities, as many scholars today maintain.

2.2 *Comparing the style of Aratus' and Eudoxus'* Phaenomena

The Cepheus-group Even when someone browses through the texts of Aratus and Eudoxus that describe the constellations of the Cepheus-group without examining them in detail, it is easy to spot the difference in the order in which each lists the members of this group. Eudoxus describes the constellations in this order: Ursa Minor, Cepheus, Serpens, Cassiopeia, Andromeda, Pisces, Aries, Delta, Pegasus,[9] Perseus, Pleiades [*In Arat*. 1.2.11–15]. Aratus, however, deals with the group in this order: Cepheus, Cynosura, Draco, Cassiopeia, Andromeda, Pegasus, Aries, Delta, Pisces, Perseus, Pleiades [*Phaen*. 179–267]. The main difference here is that Aratus jumps from Andromeda directly to Pegasus, while Eudoxus comes to Pegasus from Andromeda gradually.

Both Aratus and Eudoxus agree that the star at the tip of the tail of Ursa Minor makes an equilateral triangle with the two feet of Cepheus:

> Eudoxus
> Below the tail of Ursa Minor, Cepheus has his feet, making an equilateral triangle with the tip of her tail. His middle is near the bend of Draco between the Ursae.
>
> [Hipparchus, *In Arat*. 1.2.11]

> Aratus
> The line that extends from the tip of her tail to each of his feet equals the distance from foot to foot. And you have only to look a little way past his belt if you are searching for the first coil of the great Draco.
>
> [Hipparchus, *In Arat*. 1.2.12; Aratus, *Phaen*. 184–187]

But Hipparchus does not agree with Aratus and Eudoxus and says:

> Next, concerning Cepheus, they all[10] err [in holding] that his feet form an equilateral triangle with the tip of the [lesser] Ursa, as Aratus says.... The reason is that [the line] between the feet is smaller than each of the others, so the triangle produced is isosceles and not equilateral.
>
> [Hipparchus, *In Arat*. 1.5.19]

[9] Ἵππος/Equus (Horse): *scil*. Pegasus.

[10] Manitius 1894, 52.1 πάντες: Aratus and Eudoxus at least but perhaps other commentators as well.

A close examination of the language that Eudoxus and Hipparchus are using to describe the night-sky compared to that of Aratus brings to light significant differences. Although Eudoxus and Aratus agree about the position and the type of the triangle, they use different terminology. Aratus does not use the phrase 'equilateral triangle' that is found in Eudoxus but writes more simply that 'the line that extends from the tip of her tail to each of his feet equals the distance from foot to foot' [*Phaen*. 184–185]. Such avoidance of technical terminology serves to make his work more accessible to common people or non-experts. Eudoxus, for his part, uses the phrase without explaining it and Hipparchus not only shows no concern about how familiar this term was to his readers, he adds yet another, 'isosceles' [*In Arat*. 1.5.19].[11]

Further differences in vocabulary are also striking. Eudoxus calls a constellation Serpens (ὀ δια τῶν Ἄρκτων Ὄφις or ὀ Ὄφις), while Aratus calls it Dragon (Δράκων). The latter name first appears in Aratus [Kidd 1997, 192], whom, interestingly enough, Hipparchus follows [*In Arat*. 1.4.2]. This is another instance of the attention that Aratus pays in making his poem clear and easy to follow. In my view, Aratus changed the name from «Ὄφις» to «Δράκων» in order to avoid the confusion with the other Ὄφις (the Serpent) introduced earlier in the poem at *Phaen*. 82, a change that everyone after Aratus adopted.

This is not the only occasion in which Aratus changes the name of a constellation. This happens too when he talks about the two Ursae. Eudoxus uses the names «ἡ Μεγάλη Ἄρκτος (Ursa Maior)» and «ἡ Μικρά (Ursa Minor)» [*In Arat*. 1.4.2], and Aratus changes them to «Κυνόσουρα (Cynosura)» and «Ἑλίκη (Helice)» [*Phaen*. 36–37]. 'Cynosura' was probably an older name meaning 'Dog's Tail', but we find the name 'Helice' for the first time in Aratus [Kidd 1997, 188], a name which is most probably meant to capture the wheeling movement of that constellation around the North Celestial Pole, 'the Twister'. One can thus see that the names preferred by Aratus are more descriptive and, hence, more helpful to his readers. He implicitly refers to this difference with Eudoxus when he writes, 'One of the Ursae, men call Cynosura by name, the other Helice' [*Phaen*. 188]. The choice of these specific names also fits with the mythological descriptions that Aratus incorporates into his poem.[12]

In his grouping of constellations in the myth of Cepheus, Aratus introduces his subject as 'the suffering family of Cepheus' [*Phaen*. 179] which cannot 'be just left unmentioned: their name also has reached the sky, for they were akin to

[11] Later in his poem when he writes about Triangulum, Aratus again does not make use of the more mathematical term 'isosceles' but instead just says that two of the triangle's sides appear equal [*Phaen*. 235].

[12] Aratus uses mythology throughout the first part of his poem: see, e.g., *Phaen*. 30–35.

Figure 1.1 The Cynosura group on the Kugel Globe (3rd c. BC).

In the middle from left to right: Piscis, Triangle, Andromeda, Cassiopeia, Cepheus

Zeus' [*Phaen*. 180–181]. This group of constellations is interesting because all the figures are part of one myth. In fact, it is the only myth to be represented fully among the constellations.[13]

The Cynosura-group When Eudoxus and Aratus describe the Cynosura-group, they again place the constellations in the sky in a similar way but their accounts are very different.

> Eudoxus
> In front of Cepheus is Cassiopeia, and in front of her is Andromeda, whose left shoulder is over the more northerly Piscis; her girdle is above Aries, except that Triangulum is in between [Aries and the girdle of Cassiopeia]. A star in her head is common to the belly of Pegasus.
>
> [Hipparchus, *In Arat*. 1.2.13]

> Aratus
> In front of him revolves the tragic Cassiopeia, not very large, but visible on the night of a full Moon.
>
> [Hipparchus, *In Arat*. 1.2.14; Aratus, *Phaen*. 188–189]

[13] There are different traditions regarding the family tree of Cepheus but Aratus chooses the one that relates to Zeus. So Cepheus, a descendant of Iasus, was the son of Io [*Phaen*. 179], a king of Ethiopia, and husband of Cassiopeia, who was mother of Atymnius by Zeus and of Andromeda by Cepheus. We may assume that people in Aratus' period were familiar with the plays entitled 'Andromeda' by both Sophocles (496–406 BC) and Euripides (480–406 BC), and, thus, that they were also aware of the myth of Cepheus, since these plays were very popular in Athens at the time, as we can tell by the references in Aristophanes and the frequent portrayal of scenes from them on Attic vases. Thus, we may also assume that Aratus' readers were familiar with the mythology that he depicts in the heavens.

> There too revolves that awesome figure of Andromeda, well defined beneath her mother.
>
> [Hipparchus, *In Arat*. 1.2.14; Aratus, *Phaen*. 197–198]
>
> there shines a star that is common to its navel and the head at her extremity.
>
> [Hipparchus, *In Arat*. 1.2.14; Aratus, *Phaen*. 206–207]
>
> but you can still identify it from the girdle of Andromeda: for it is set a little way below her.
>
> [Hipparchus, *In Arat*. 1.2.14; Aratus, *Phaen*. 229–230]
>
> Let Andromeda's left shoulder be your guide to the more northerly Piscis, for it is very close to it.
>
> [Hipparchus, *In Arat*. 1.2.14; Aratus, *Phaen*. 246–247]

The differences concern mainly the vocabulary that each author chooses and the picture that they give us. Eudoxus uses the verb 'to be' («εἶναι») to indicate where Cassiopeia and Andromeda are as well as to say where the northerly Piscis is, while Aratus uses the verb 'to revolve' («προκυλίνδεσθαι»). The difference between Eudoxus' two-dimensional and motionless picture of the heavens and Aratus' rotating sky with three-dimensional figures that are alive and move might be expected: it is definitely one of the features that separate the former's prose and the latter's poetry. Such use of mythology and anthropomorphism is typical of Aratus' descriptions. But what we would not necessarily expect is to see how many of Aratus' descriptions and notions became standard practice among his successors. For example, the name «Δράκων» appears for the first time in Aratus, and Hipparchus adopts it instead of Eudoxus' «ὁ διὰ τῶν Ἀρκτῶν Ὄφις» or simply «Ὄφις».

In addition to his preference for a moving, three-dimensional cosmos is Aratus' introduction of more stars than Eudoxus in his description of each constellation and his focus on the shape and brightness of the constellations and the stars.[14] This extra information is crucial for Aratus' audience: they can learn how the constellations and the stars should appear to them, how well defined they are, and how easily they can spot them depending on their brightness:

> there shines a star that is common to its navel and the head at her extremity.
>
> [Hipparchus, *In Arat*. 1.2.14; Aratus, *Phaen*. 206–220]

[14] See, for instance, the star(s) in: Draco [*Phaen*. 55–57], Arctophylax [94–95], Virgo and Ursa Maior [136–146], Taurus [170–176], Cassiopeia [190–195], Pegasus [206–214], Pisces [244–245], Sirius or the Dog-Star [329–337, 339–341]. See also the unnamed stars in *Phaen*. 367–385, 389–401.

> only a few zigzagging stars adorn her [Cassiopeia], giving her all over a distinct outline.
>
> [Aratus, *Phaen*. 190–191]

> the three other stars mark off lines of equal length…they are beautiful and bright.
>
> [Aratus, *Phaen*. 208–210]

> Aries itself is faint and starless.
>
> [Aratus, *Phaen*. 228]

But the *Phaenomena* not only guides its readers in exploring the night-sky, it actually urges them to do this. Aratus actually addresses his readers by using the second person. Examples from his descriptions of two groups of constellations discussed above are as follows:

> you can still identify it.
>
> [Aratus, *Phaen*. 229]

> I do not think you will have to look all round the night sky in order to sight her very quickly.
>
> [Aratus, *Phaen*. 198–199]

> you have only to look a little way past his belt if you are searching for the first coil of the great Draco.
>
> [Aratus, *Phaen*. 186–187]

In this way, Aratus calls upon his readers to see for themselves, presenting his observations as something accessible to everybody, where this accessibility is effected by means of the terminology that he chooses. The use of mythology and the correlation of groups of constellations to specific groups of mythological characters helps as well. It is not only that the poem becomes more approachable and vivid to the reader but that, on top of this, mythological names and scenes also help them to find the constellations more easily and to memorize them. Aratus' verbal star-map is one to be remembered.

3. Comparing the content of Aratus' and Eudoxus' *Phaenomena*

I will now present examples to support my argument that Aratus changed his source not only by using different terminology and addressing the needs of an observer of the night sky, but also by changing specific astronomical data. When going through the description of the night sky in a comparative way, one sees that Aratus actually changes the content of Eudoxus' account either by placing the constellations differently or by mentioning that different parts of them rise and set with particular zodiacal signs. The following analysis goes hand in hand with the changes that Aratus made to update the astronomical information in Eudoxus' *Phaenomena* with the knowledge of his time, i.e., that there is no star

at North Celestial Pole and the treatment of the observer's eye as the center of the cosmos.[15]

3.1 *The celestial circles*

My first example is the group of celestial circles described by both writers and, in particular, the Tropic of Cancer. Eudoxus discusses the solstices [Hipparchus, *In Arat* 1.2.18, 1.2.20, 2.1.20], the equinoxes [2.1.20.], the Arctic Circle [1.11.1, 1.11.5.], the colures or circle passing through the celestial poles and the equinoctial points [1.11.17, 1.11.19, 2.1.21], and the zodiacal band [*In Arat*. 1.9.1–2]. Aratus, however, omits the colures and deals with the solstices [*Phaen*. 480–510], the equinoctial circle [*Phaen*. 511–524], the zodiacal band [*Phaen*. 525–558], and the Milky Way [*Phaen*. 525–558]. The latter is absent from Eudoxus' description, perhaps because such a circle, though definitely interesting for any lay-observer of the night sky, may not have been very interesting to the astronomers of his time.

3.2 *The Tropic of Cancer*

As for the Tropic of Cancer, the celestial circle on which we have the summer solstitial point, both authors agree that the left shoulder and the left leg of Perseus, the knees of Auriga, and the heads of Gemini lie on this circle [Hipparchus, *In Arat*. 1.2.18; Aratus, *Phaen*. 480–496]. Eudoxus additionally mentions the right hand of Heracles[16] and the nape of Serpens [Hipparchus, *In Arat*. 1.2.18], which Aratus omits altogether. Notice too that Eudoxus goes on to say that on the Tropic of Cancer lies the head of Ophiuchus [Hipparchus, *In Arat*. 1.2.18], though Aratus mentions only the shoulders of that constellation [*Phaen*. 487]. Furthermore, Eudoxus mentions that the right hand of Andromeda and the distance between her feet lie on the circle [Hipparchus, *In Arat*. 1.2.18], while Aratus maintains that

> Andromeda's right arm [is] above the elbow; her palm lying above it, nearer the north and her elbow inclining to the south.
>
> [Aratus, *Phaen*. 484–486]

Finally, Eudoxus says that the feet of Pegasus and Cygnus'[17] nape and left wing are on the tropic of Cancer [Hipparchus, *In Arat*. 1.2.18]; whereas, in Aratus' poem, it is the hooves of Pegasus and Cygnus' neck [Aratus, *Phaen*. 487].

More differences yet have to do with the constellations that rise and set when Cancer and Aquarius rise, according to Aratus and Eudoxus. I have schematized the two accounts to make the differences clearer. In brackets are the differences

[15] For discussion of these changes, see Mastorakou 2019.

[16] In Greek, this is ὁ Ἐγγόνασιν (the Kneeler) *scil*. Heracles; in Latin, Ingeniculatus (the Kneeler) *scil*. Hercules.

[17] The constellation Ὄρνις (Bird) is thought to be Cygnus.

Co-Rising Constellations		Co-Setting Constellations	
Aratus	Hipparchus	Aratus	Hipparchus
◦ Orion with his belt and two shoulders [all of the River]	◦ the whole of Orion	◦ half of Corona ◦ as far as the spine of the northern Piscis ◦ the parts up to the belly of Heracles ◦ Ophiuchus as far as his shoulders [from knees to shoulders] ◦ the Serpens as far as its neck [close to the neck] ◦ the bigger part or half of Boötes	◦ half of Corona ◦ the head of the northern Piscis ◦ all of Heracles ◦ the head of Ophiuchus ◦ the tail of the Serpens ◦ the head of Boötes

Table 1.1. When the constellation Cancer rises
[Hipparchus, *In Arat.* 2.2.2–30]

between the fragments of Aratus' *Phaenomena* presented in Kidd's edition [1997] and the same fragments in Hipparchus' commentary.

Table 1, p. 10 shows how extensively Aratus' work differs from changed Eudoxus'. Except for Corona—both agree that half of it sets as Cancer rises—everything is quite different. One might think that Eudoxus and Aratus may be describing different phases of the rising and setting of the constellations. For example, Aratus mentions the part that has already gone, and Eudoxus, the part that is setting. But that hardly works for most of the constellations which they mention.[18] The obvious conclusion is that Aratus differentiates himself from Eudoxus by presenting his reader with more recent thinking about the celestial sphere.

Beyond mentioning different parts of setting and rising constellations, Aratus also omits whole constellations that Eudoxus includes in his account. See Table 2, p. 11.

Although Aratus and Eudoxus mention that the same constellations set when the Aquarius rises, there is the important difference that Eudoxus mentions two

[18] I am not aware of two different traditions of describing the risings and settings of the constellations but it would be interesting to investigate this further. It might be something similar to the two different ways of depicting the constellations on celestial globes, viz. from the front or the rear or a mixture of both.

Co-Rising Constellations

Aratus	Hipparchus
◦ the head and the feet of Pegasus ◦ the back of the Centaur ◦ Hydra's head until her first coil [Hydra's neck-coil and all the stars in its head]	◦ Horse ◦ Centaur ◦ Hydra ◦ Cassiopeia ◦ Delphinus

Table 1.2. When the constellation Aquarius rises
[Hipparchus, *In Arat.* 2.3.4–10]

additional ones, namely, Cassiopeia and Delphinus, which Aratus completely omits. Here again Aratus changes Eudoxus' account, and Hipparchus' version agrees. Indeed, Hipparchus says, first, that Cassiopeia sets with Sagittarius and Aquarius; and, second, that the Delphinus as a whole sets with Sagittarius. Aratus thus avoids the erroneous information that Eudoxus includes in his work, something that Hipparchus does not acknowledge.

Intriguingly, for his own reasons, Hipparchus does not usually credit Aratus for correcting information found in Eudoxus' work. Perhaps, as I mentioned earlier, it is because, in his hierarchy of technical competence or understanding of the heavens, Eudoxus is superior to Aratus. There are, however, a few instances when Hipparchus does admit that Aratus is right and that Eudoxus or Attalus is wrong, for instance, when he comments that the simultaneous risings recorded by both Eudoxus and Aratus are more correct for the division of the zodiacal band assumed by Aratus [*In Arat.* 2.2.6].

In general, Hipparchus is selective in his reports of Aratus' work, perhaps because he is primarily interested in describing where each of the constellations is and has little interest in anything else. It should not surprise us, in any case, that Hipparchus does not include Aratus' mythological descriptions, the similes that he deploys, the meteorological references and weather-signs, the role of Zeus, or even information about the stars' sizes and their brightness, or how one can find a constellation in the sky. All these omissions have, I think, to do with Hipparchus' focus in his work and and the attendant style. Despite claiming in the preface that he wants to correct Aratus' work for the benefit of everybody, Hipparchus is very careful to exclude aspects of astronomy that do not fit the discipline as he sees it: for him, this discipline is mathematical astronomy and his targeted readers are, like himself, its practitioners. The result is that he did not really aim to reach a general educated public (beyond impressing it with his

expertise). This is suggested, for instance, by his omitting to tell his reader how to find the constellations in the sky or his assuming that his reader already knows how to do that. It could be said that, since this is a commentary on Aratus, the reader is assumed to be familiar with Aratus' poem already; so there would be no point in Hipparchus' re-stating this sort of information. But overall, one gets the strong sense that Hipparchus is trying to create a specific picture of Aratus which is inextricably linked to the one that he wants to create for himself. By focusing for the most part on Aratus' incorrect statements, Hipparchus shows that he wants to emphasize the difference between a good, professional mathematician/astronomer and someone who only writes poems following mathematical works by others. That is why, although Hipparchus mentions that Aratus and Eudoxus agree on one description, when he wants to say that he disagrees with that account, he typically sets himself in opposition only to Aratus, even though both Aratus and Eudoxus are wrong. He writes, 'as Aratus says' [e.g., *In Arat*. 2.2.31–35] and not for instance 'as they both say'.

Aratus' account of the heavens, then, is the one that Hipparchus is trying to correct and eventually replace.

This means that with Aratus we have the close of one era of celestial knowledge and the start of another in the second century BC with Hipparchus. Curiously, such a gap between Aratus (315–240 BC) and Hipparchus (190–120 BC) is evident in the the sequence of the major contributors to astronomy up to and including Hipparchus that is acknowledged by ancient writers. Be that as it may, there is evidence enough that Aratus' poem marks the close of an era culminating in the wide dissemination and popularity of astronomical knowledge [Mastorakou 2019] and that Hipparchus, in order to establish his own account, undertook not only to re-present the facts but also to re-cast their presentation in prose, a goal that apparently required 'correcting' Aratus' *Phaenomena* and diminishing any role that it had played in the history of that science.

4. Conclusion

I have drawn attention to Aratus' and Eudoxus' works on the fixed stars. On looking closely at the content and presentation style of the two works, it is clear that Aratus not only changes the language of his source, he also modifies the actual content of the prose-work on which his poem is based. Both Eudoxus and Aratus locate the constellations in relation to one another spatially but Aratus also exhibits an interest in their appearance and brightness as well as in the legends associated with them. The result is a vivid poem, which attracts and holds the reader's attention on the night-sky and all its wonders. When it comes to the actual astronomical detail that the poem provides, there are again changes in the content, changes either in line with the updated knowledge of Aratus' time or omissions whenever Eudoxus' information was incorrect or ambiguous.

In effect, we see Aratus providing an account that would be easier for non-experts (who are in the majority) and thus more readily transmitted to the next generations. Aratus seems to be the last in a long astronomical tradition. He is the one who sums up the non-technical astronomical knowledge of his period to give it to the general public. But note: Aratus did not write a poem on popular astronomy; he wrote an astronomical poem through which astronomy became popular. Indeed, astronomy had a prominent place in Hellenistic education—in contrast to mathematics for example—and it kept this role and commanded high popular interest for many centuries.

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