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*Quis dubitet hominem
coniungere caelo?*

a cura di
Elio Antonello

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Sirius was already white

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Abstract. Commonly, the adjective *ὑπόκιρρος*, that Ptolemy used for only six different stars in his *Almagest* and for only three stars in his *Tetrabiblos*, is translated “reddish”. Since these stars have very different colours at the present, modern astronomers felt to be compelled to try to explain why, according to Ptolemy, Sirius should have been “reddish” instead of white (as it really is), and they presented several hypotheses. Here we propose: 1) a “strong” hypothesis that the adjective *ὑπόκιρρος* means “yellowish”; 2) a “weak” hypothesis that *ὑπόκιρρος* means “iridescent”; 3) the witness written in the *Avestā*, the holy book of the Zoroastrian religion, that the colour of Sirius before Ptolemy was white.

1. Introduction

In the Star Catalogue of his *Μαθηματικὴ Σύνταξις*, commonly known as *The Almagest*, Ptolemy describes 1022 stars from first to sixth magnitude, but only for six of them he uses an adjective – *ὑπόκιρρος* – that always had been translated as “reddish”. The six stars are: Aldebaran (spectral class K5), Antares (spectral class M1), Betelgeuse (spectral class M2), Arcturus (spectral class K1), Pollux (spectral class K0), Sirius (spectral class A1). For human eyes two of these stars – Antares and Betelgeuse – seems to be red; two – Aldebaran and Arcturus – seems to be orange; one – Pollux – seems to be yellow and the last one – Sirius – seems to be white.

In his book *Τῶν πρὸς Σύρον ἀποτελεσματικῶν τέσσαρα βιβλία*, commonly known as *The Tetrabiblos* (Feraboli 1982, pp. 42, 44, 48), Ptolemy uses the same adjective *ὑπόκιρρος* only for three stars: Aldebaran (named here *λαμπαύρας* = bright), Antares and Arcturus; he does not use any adjective for Betelgeuse, Pollux and Sirius. This opens three questions:

- 1) What is the exact meaning of the adjective *ὑπόκιρρος*?
- 2) Why Ptolemy used an adjective only for six out of 1022 stars in his

Almagest Star Catalogue (Heiberg 1903; Toomer 1998)?

3) Why did he use the same adjective for so differently coloured stars?

2. Schiaparelli's hypotheses

The common translation of *ὑπόκιρρος* into reddish pushed astronomers to try to explain how it is possible that a reddish star changed its colour into white in a time span less than one millennium, because the Muslim astronomer Al Sufi describes Sirius as a white star in the 10th century AD (Ferreri 2015, p. 40).

Because Sirius is a double star, a modern hypothesis tries to explain the change of colour as the transformation of Sirius B, previously giant and red, into the present white dwarf star (Ferreri 2015, pp. 40 – 42). But this hypothesis is not very convincing.

The Italian astronomer Giovanni Virginio Schiaparelli wrote, respectively in 1896 and in 1897, the two important reports *Rubra Canicula. Considerazioni sulla mutazione di colore che si dice avvenuta in Sirio* and *Rubra Canicula. Nuove considerazioni sulla mutazione di colore che si dice avvenuta in Sirio* (De Meis, Gnoli, Panaino 1998, pp. 179 – 234), by supposing that the change of colour was only a translation mistake since the Roman Age. He supposed, with convincing arguments, that the Latin translation “*Rubra Canicula*” – i.e. the “little female reddish dog” – is related not to Sirius but to the red star Procyon in Canis Minor constellation, that rises some days before Canis Major. Indeed Schiaparelli describes the ancient Greek myth of Icarus, of his daughter Erigone and of their little female dog Maira who were all changed in heavenly constellations (respectively: Bootes, Virgo and Procyon or Canis Minor) by the Olympians Gods. He describes also an ancient Latin sacrifice – the *Robigalia* – on occasion in which, every 25th April, Romans sacrificed a little red female dog to Robigo, the goddess of the rust. Schiaparelli infers that *Rubra Canicula*, Maira, the *Robigalia* and Procyon had the same meaning and that Romans mistook the red star Procyon for Sirius.

3. Etymological discussion

We think that this confusion between Procyon *Rubra Canicula* and Sirius *ὑπόκιρρος* led wrongly to translate this adjective as reddish. But *ὑπόκιρρος* does not mean reddish!

3.1. The meaning of *κιρρός*

According to the dictionaries Gemoll (1936)⁷ and Rocci (1948), the meanings for *ὑπόκιρρος*, *κιρρός* and their compounds are the following:

- a) *κίρρος* or *κιρρός* = pale, yellow;
- b) *ὑπόκιρρος* = yellowish;
- c) *κιρράς* = yellow;
- d) *κιρροειδής* = yellowish; pale;
- e) *κιρροκοιλάδια* = figs with yellow pulp;
- f) *κιρρώδης* = yellowish.

The adjective *κιρρός* gives in modern languages the medical word “cirrhosis”, because the liver becomes yellow owing to the adipose (or fat) infiltration: *κίρρωσις* = *κιρρός* (yellowish) and *-ωσις* (condition). Basically, the ancient authors used these adjectives meaning yellow or white. For instance, Hippocrates wrote *ὑπόκιρρος οἶνος*, means “white wine”. Therefore, *ὑπόκιρρος* does not mean a dark colour, as reddish, but, rather, a very clear colour as yellowish or whitish, that is the current colour of Sirius. Note that, in ancient Greek, *σείριος* means “hot”, “burning”. Eratosthenes, in his work *Καταστερισμοί* (Westermann 1843), wrote “Seirios on the head [or tongue]. This star is large and very bright (*λαμπρόν*¹) and the stars similar to it are named Seirioi by astronomers because of the movement of the flame”. The movement of the flame is important! So the very true question is: why Ptolemy used an adjective that means “yellowish or whitish”, not “reddish”, for red stars such as Antares, Betelgeuse and for orange stars such as Aldebaran and Arcturus²?

In ancient Greek grammar *ὑπόκιρρος* is a compound word (*ὑπό* + *κιρρός*), but the word *ὑπό* is a preposition (Latin: *ipo-*; English *hypo-* = sub, under, down, below) which placed before the adjectives decreases their characteristics (downgrading the original word): for example: *υποαλλεργικό* (=hypoallergenic), *υποθερμία* (=hypothermia). This fact alone is enough to cancel the “red–theory” even if some researchers wrongly translate the adjective *κιρρός* as “red”, influenced by the Latin “*ruber, rubra, rubrum*”.

¹ *λαμπρόν* is the adjective more often used in the catalogue of the stars in the *Almagest*.

² For the yellow star Pollux, *ὑπόκιρρος* may be fitted.

3.2. *Κιρνάω, κεραννύω, κεράω, κεράννυμι*

Another fact is that *κιρρός* may have the same root of *κιρνάω, κεραννύω, κεράω, κεράννυμι*, meaning basically “to mix”, signifying the mixing and consequently the “change” (of colour, consistency, etc.). Indeed, these verbs were used (for instance in Homer) to signify the mixing of the wine with the water. But when the dark wine is mixed with water its colour changes, becoming more clear or “pale” (i.e. *κιρρός*). In other words, the colour *κιρρός* may derive its meaning “yellow, pale” from the change of the colour of dark wine mixed with water.

3.3. *The colours in the antiquity*

It seems that in ancient languages the colours did not exist in the abstract sense as in modern ones³, but the colours were derived from material objects having that colour (for instance: the red of the fire; the blue of the sky; etc. and the “bleaching” of the dark wine mixed with water)⁴.

When Greek words were taken into Latin, the letter “K” was transliterated as a “C”. Loanwords from other alphabets with the sound /K/ were also transliterated with C. Hence, the Romance languages generally use C and have K only in later loanwords from other language groups. The Celtic languages also tended to use C instead of K, and this influence carried over into Old English (<https://en.wikipedia.org/wiki/K>).

Let's see now some examples about the preposition *ὑπό* from the book written by Pedanius Dioscorides, *De Materia Medica* (*ΠΕΔΑΝΙΟΥ ΔΙΟΣΚΟΥΡΙΔΟΥ ΑΝΑΖΑΡΒΕΩΣ, Περὶ ὕλης ἰατρικῆς*) (Wellmann 1906). We can see how this preposition can transform (“decrease” in this case) the adjective/colour but we can also understand the colours through the eyes of ancient people, as a comparison of ancient and modern colours in the same object:

- a) Wax <*κηρός*> = *ὑπόκιρρος* = subpale [Vol II, 83]⁵
- b) Sea daffodil bulb (*Pancratium Maritimum*) <*παγκράτιον*> = *ὑπόπυρρος* (reddish, sub+color of the fire, *pyrros*)[Vol II, 172]
- c) Honey <*μέλι*> = *ὑπόξανθον* (sub+color of blond hair, blond = *xanthos*)

³ Probably only the difference between brightness and darkness.

⁴ Personal communication to us by prof. Mario Caprini and prof. Rita Caprini.

⁵ The numbers between square brackets are referred to the volumes, chapters and lines of Dioscorides's book.

[Vol II, 82]

d) Anemone (for the white species) <ἀνεμώνη> = ὑπόλευκα (sub+white, whitish, white = lefkos) [Vol II, 176]

f) Thlaspi Arvense <θάλασπι> = ὑπόλευκον (sub+white, whitish, white = lefkos) [Vol II, 156]

An other example (Ulrichs 1843): *albōgilvus*, *a*, *um* = ὑπόλευκος, κίρρος⁶ (= whitish, kirros). Other synonyms for ὑπόλευκος are: ivory, pale, pallid, creamy-white, broken-white, off-white.

3.4. The root *κιρ/*κηρ and the Linear B

An additional hypothesis is that some words derived from the same root and widespread in several cultures are related. The word <kerā> (κέρας), the root of which may be *κιρ/*κηρ, is already present in the Linear B until today. Its meaning is “horn”. Some derivatives words are: Ceratophyllum, rhinoceros, keratin, cheratina, cranium, cranio (skull), cranosn (helmet). Common-root in Linear B is: <ka-ra-pi>, cara (cerebrum, head). But the same root you can actually find in the modern and ancient Greek adjective κίρρος = “pale”, that Macedonians pronounce κερρός, with an ε = e instead of an ι = i (Hoffmann 1906). Here we have the same meaning with two different pronunciations! Moreover, the colour of the horn is generally a kind of lighter or darker “yellow”: i.e. “pale”. The same root *κιρ/*κηρ may also appear in some words meaning baked clay, pottery, the colour of which is generally “pale”.

These examples proof again, that the original meaning of the adjective ὑπόκιρρος is not reddish but “yellowish”, “whitish”, at least “pale”.

4. Avestā's and other witnesses

Regarding the colour of Sirius, we have a witness prior to Ptolemy that describes it as a white star: in the Avestā (Alberti 2008, pp. 320 – 329), the holy book of the Zoroastrian religion, the Yašt Tīr n. 8 is devoted to the star Tištria, that is the yazata (i.e. roughly the angel) of the star Sirius. The Yašts are thirty hymns, one for each day of the months, devoted to the “yazata”. Some of them precede the Zarathuštra's religious reform (about 9th century BC or before). They were composed during the 1st millennium

⁶ Note that the Latin adjective *albus*, *-a*, *-um* means “white”. This is another proof that κίρρος – and even more so ὑπόκιρρος – does not mean “reddish” but “whitish.”

BC, i.e. before the Ptolemy's Almagest. Yašt Tīr n. 8, vers No. 2, sings:

“We offer up libations unto Tištrya, the bright and glorious star, that gives happy dwelling and good dwelling; the white⁷, shining seen afar, and piercing; the health-bringing, loud-snorting, and high, piercing from afar with its shining, underfiled [immaculate]⁸ rays, and unto the waters of the wide sea, the Vanguhi of wide renown, and the species of the Bull, made by Mazda, the awful kingly Glory, and the Fravashi of the holy Spitama Zarathushtra”⁹.

Moreover, some extant ancient Chinese texts – from 100 B.C. to 646 A.D., i.e. about contemporary to Ptolemy – also report that the colour of Sirius was absolutely white, as Vega. (Jiang Xiao-Yuan 1993): 1) *Shiji Tianguanshu* (Historical Records, Book of asterisms) written by Sim Qian in 100 B.C. 2) *Hanshu Tianwenzhi* (History of Han, Astronomical Chapter) written by Ban Gu, Ban Chao and Ma Xu in 100 A.D. 3) *Jinzhou Zhan* (Jinzhou Book of Prognostication) written by Liu Biao in 200 A.D. 4) *Hanshu Tianwenzhi zhong* (History of Jin, Astronomical Chapter, Book 2 of 3), written by Li Chun-Feng in 646 A.D.

Note that Vega is mentioned in the Avestā too: the short Yašt 20 is fully devoted to Vanant, that is probably the star Vega (α Lyrae), named the “star of the rains”. Vanant is mentioned in the Yašt 8,12 too, with Tištrya (Sirius, that is named here “the first star”) and the stars Haptōiringa, that seem to be the stars of the Ursa Major (the Great Bear or the Plough). Here is the full verse 12 of the Yašt 8, according to www.avesta.org: “We sacrifice unto Tishtrya; We sacrifice unto the rains of Tishtrya. We sacrifice unto the first star; we sacrifice unto the rains of the first star. I will sacrifice unto the stars Haptoiringa, to oppose the Yatus and Pairikas. We sacrifice unto Vanant, the star made by Mazda; for the well-shapen strength, for the Victory, made by Ahura, for the crushing Ascendant, for the destruction of what distresses us, for the destruction of what persecutes us. We sacrifice unto Tishtrya, whose eye – sight is sound”.

Also Schiaparelli, in his article of 1896 (De Meis, Gnoli, Panaino 1998, pp. 205 – 209), listed and discussed the ancient authors who described Sirius as a white star or, at least, not as a reddish one: Julius Iginus; the

⁷ The underlining is ours.

⁸ The underlining is ours.

⁹ English version by “Avesta Zoroastrian Archives” www.avesta.org.

scholiast of Aratus; Manilius; Rufus Festus; Hefestio of Thebes (in Egypt). The last of them, particularly, described four colours (big and white; gold; red; little and pale) and four qualities (big and bright; dull; little and dim; dark¹⁰) that Sirius could show during its heliacal rising¹¹, heralding the Nile's floods. This mutability of Sirius, due to the atmospherical refraction, is in agreement with our "translation" of the adjective *ὑπόκιρρος* as "iridescent". In Table 1 are listed height and time UT of Sirius' culmination, calculated by FK5 J2000.0¹² at the dates of 1st January 150 AD (the approximate year in which Ptolemy wrote his *Almagest*), 141 BC (the approximate year in which Hypparcus wrote his *Stars' Catalogue*) and 290 BC (the year in which Timocaris and Aristillus wrote their *Star Catalogue*):

Table 1. Sirius' culmination at Alexandria in Egypt.

Date	Height	UT
150 AD	42°55'	20:43
141 BC	42°43'	20:40
290 BC	42°34'	20:37

5. Conclusions

Κιρρός does not mean reddish but yellow and therefore, *ὑπόκιρρος* (or *ὑποκιρρός*) means "less than yellow", which is the true colour of Sirius. But the question is: as this adjective does not fit on to the other four "reddish" stars Aldebaran, Antares, Betelgeuse, Arcturus, as listed by Ptolemy, why Ptolemy used the same adjective for so different and only six stars, while he named 1022 stars, for which he used only the adjective *λαμπρός* = bright?

Since the verbs *κιννάω*, *κεραννύω*, *κεράω*, *κεράννυμι* (that may have a common root **κιρ/*κηρ*) mean "to mix", because these verbs are used by ancient authors to express the action of the mixing of wine and water – in consequence of which the red wine change its colour and becomes more

¹⁰ *μέγας καὶ λαμπρός; μέλας; μικρός καὶ στύγνος; σκοτεινός.*

¹¹ For astrologers who had to foresee the discharge of the Nile's flood.

¹² Integrated by Agostino Frosini in his JavaScript software *Effemeridi VSOP87* using the algorithms printed in Meeus 2005, chapters 21, 22, 23, 32, appendix III, and Meeus 2014, chapters 12, 13, 14, 22, 35. *Effemeridi VSOP87* can be downloaded from http://www.agopax.it/Archaeoastronomy%20Program/pagina_iniziale.html

pale – we suggest the hypothesis that *ὑπόκιρρος* meant in Almagest the quick change of colour of these six bright stars, i.e. their *iridescence*. This is only a proposal of course, a work hypothesis without proofs, not a certainty! On the other side, our purpose in this article is not to search for the true meaning of the adjective *ὑπόκιρρος* but to check if it means reddish, as commonly translated, and consequently if Sirius was once truly reddish and changed its colour in less than one millennium. We think, with adequate certainty, that we proved here that it does not mean reddish¹³. Moreover, we found the new, unpublished witness of Avestā, supported by Chinese witnesses and by the authors listed by Schiaparelli nearly contemporary of Ptolemy, which demonstrates that Sirius, at the age of Ptolemy, was white.

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¹³ There are not yet enough data to state with certainty what Ptolemy wanted to signify with *ὑπόκιρρος*.

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