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Is Sirius a triple star?

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Abstract. Sirius has been discovered as double more than 130 years ago. From the beginning of our century up to now, observational as well as physical and dynamical indications lead to the hypothesis of the existence of a third body in the system. In this paper, we present recent orbital analysis of the binary Sirius A–B which, helped by numerical simulation of triple systems, strengthens the idea for the triplicity of Sirius: a tiny star could revolve in about 6 years around Sirius A*. Finally, we discuss the possibility of direct detection for this suspected Sirius C.

Key words: stars: αCMa – celestial mechanics – binaries: general – low mass stars, brown dwarfs

1. Introduction

Sirius, "The Bright" of the ancients, forms, with its companion discovered a little more than 130 years ago, one of the most amazing double – and maybe triple – star.

Measured as soon as the ancient Egyptians established the relation between the Nile in spate and the first seeing of "Sothis" at dawn – the "heliacal rising" –, Sirius plays an important role in astronomy, for example in the discovery of stellar proper motions (see e.g. Lacaille 1764); in other respects, everybody knows that the evolutionary interrelations between the two stars is still an open question.

The proper motion of Sirius itself, well known since Halley's times, shows periodic variations. Bessel proposed in 1844 the hypothesis that these variations are due to an unseen companion. A theoretical orbit for the suspected double star was computed by Peters in 1851, Safford in 1861 and Auwers in 1862; in this latter year, Alvan Clark actually discovered the now well-known white dwarf Sirius B; the main star of the binary is therefore called Sirius A. So Sirius' companion is one of the first heavenly bodies the existence of which had been predicted through its gravitational effects, together with Neptune.

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* Tables 2 and 3, and the table in Appendix are available in electronic form at the CDS via *anonymous ftp 130.79.128.5.*

Since then, the 2 stars have revolved around each other more than 2 times; the current values of the orbital elements are those computed by Van den Bos in 1960 (Fig. 1). The angular distance between Sirius A and B varies from around 4″ at periastron, where the companion is lost in the very brightness of the most shining star in the Earth's sky, up to almost 12″ at aphelion.

As soon as 1894, irregularities were found in the motion of Sirius B, and lead to suspect the existence of a third body in the system. Moreover, observations, mainly in the 1920's, and reflexions on physics of Sirius A, came and supported this hypothesis. But this is still controversial, as we will see below (for more historical details about this section, see e.g. Allen 1963; Baize 1931, 1987; Benest 1987).

1.1. The controversial Sirius C

A tiny star ($m_v \approx 12$) has been observed about twenty times between 1920 and 1930. If there was a real object and not a "phantom" – the observers themselves were sometimes in doubt –, an orbit of around 2 years could roughly agree. However, we will see that this period does not fit with the results of the orbital analysis.

On the other hand, an analysis of the radial velocity of Sirius A between 1899 and 1926 led Voronov (1933, 1934a,b) to the hypothesis of the duplicity of Sirius A, with an orbital period of 4.5 years. Heintze (1968) also suspected such a duplicity, from the spectrum of this star, and concluded in favour of a relatively close companion of Sirius A. However, Lindenblad (1973), after photographic measurements over 6.8 years, did not find any significant perturbation. Moreover, Gatewood & Gatewood (1978) analyzed 60 years of observations with the Allegheny and Yerkes refractors, and concluded that nothing supports the hypothesis of a third body. Nevertheless, recent discussions about a possible change of color of Sirius during historic times (Schlossen & Bergmann 1985; Tang 1986; van't Veer & Durand 1988; Gry & Bonnet-Bidaud 1990) relaunch the debate: if the phenomenon is real, one of the possible explanations is the existence of a third body; Bonnet-Bidaud & Gry (1991) have observed the vicinity of Sirius and proposed several faint stars ($m_v \geq 17$) as candidates, but they are all so far from