

# Transit of Luyten 726-8 within 1 ly from Epsilon Eridani

Igor Yu. Potemine\*

## Abstract

This is one of results from our program of massive simulations of close encounters for all nearby stars. Epsilon Eridani is an extremely interesting star having one confirmed planet and multiple asteroid and debris belts. It should have a quite massive Oort cloud as well. Deltorn et al. searched for past Nemesis encounters of  $\varepsilon$  Eri. In this paper we show that, according to current astrometric data, another famous nearby star Luyten 726-8AB (=BL/UV Ceti) will pass at  $\lesssim 0.93$  ly from Epsilon Eridani in  $\approx 31.5$  kyr. So, it will probably pierce through the outer part of the hypothetical Oort cloud of  $\varepsilon$  Eri. BL/UV Ceti has only about 20 percent of the solar mass. Nevertheless, it could influence directly some long-period comets of Epsilon Eridani. The duration of mutual transit of two star systems within 1 ly from each other is  $\gtrsim 4.6$  kyr. Our simulations show that stellar encounters within 1 ly might be more frequent than previously thought. It could explain Proxima's peculiar trajectory with respect to  $\alpha$  Cen AB or even Sedna's trajectory in the solar system.

## 1 Introduction

Epsilon Eridani is a relatively young K-star having one confirmed planet, two asteroid belts at  $\sim 3$  and  $\sim 20$  AU resp. as well as an analog of Kuiper belt starting at 35 AU from the star. It should also have the outer cloud of long-period comets more massive than the Oort cloud in our solar system. The literature on  $\varepsilon$  Eri is very extensive, *cf.* 1159 references currently available in SIMBAD database for additional details.

BL/UV Ceti was discovered by Luyten in 1948-49 as a star with a very high proper motion. UV Ceti is actually an archetype of flare stars famous for its extreme changes of brightness. Two components are at few AU from each other on highly elliptical orbits. The total mass of the system is about  $0.2M_{\odot}$ . Luyten 726-8 is also the closest currently known neighbour of Epsilon Eridani (*cf.* SIMBAD database for an extensive list of references).

Deltorn and Kalas [1] searched for past close encounters of  $\varepsilon$  Eri. They have discovered that Epsilon Eridani had recently a close encounter with

---

\*Université Paul Sabatier, Institut de Mathématiques de Toulouse (IMT), 118 route de Narbonne, F-31062 Toulouse Cedex 9, France, igor.potemine@math.univ-toulouse.fr

Kapteyn’s star at the mutual distance of  $\approx 1$  pc. So, as far as I know, it is somewhat unexpected that it will have a much closer encounter just with its currently nearest neighbour!

## 2 Distance and time of the closest encounter

The linear approximation gives very accurate results within  $\pm 100$  kyr. Let us denote Epsilon Eridani by  $X$  and BL/UV Ceti by  $Y$ . Using HIP2 data for  $\varepsilon$  Eri as well as RECONS parallax and SIMBAD data for BL/UV Ceti, we get the following relative position of  $Y$  with respect to  $X$  :

$$\vec{r}_{XY} = (4.5962, 2.0840, -0.6559) \text{ ly} \quad (1)$$

in rectangular galactic coordinates and Julian light-years. Thus, the current distance  $d_{XY} = \|\vec{r}_{XY}\|$  between Epsilon Eridani and Luyten 726-8 is  $\approx 5.09$  ly. Radial velocities of stars  $X$  and  $Y$  are  $v_{r,X} = 16.3 \pm 0.1$  (PCRv, [2]) and  $v_{r,Y} = 21.9 \pm 0.1$  (Malaroda et al., [3]). We will also use an older measurement  $v_{r,Y} = 29 \pm 2$  from GCRV.

Table 1: HIP2 and PCRv data for  $\varepsilon$  Eri; RECONS parallax and radial velocities from Malaroda+ and GCRV for BL/UV Ceti.

| Id                | $\pi_X$<br>(mas) | $v_t$<br>(km/s) | $v_r$<br>(km/s) | U<br>(km/s)      | V<br>(km/s)      | W<br>(km/s)      |
|-------------------|------------------|-----------------|-----------------|------------------|------------------|------------------|
| $\varepsilon$ Eri | 310.74           | 14.87           | +16.3           | -3.54            | +7.09            | -20.59           |
| BL/UV Cet         | 373.70           | 42.42           | +21.9<br>+29    | -41.83<br>-43.57 | -19.40<br>-19.27 | -12.36<br>-19.24 |

The transverse velocity  $v_t$  is easily calculated from the parallax and total proper motion (*cf.* [4], sect. 2). So, we get the following relative space velocities:

$$\vec{\mu}_{XY} = (-38.29, -26.49, +8.23) \text{ or } (-40.03, -26.36, +1.35) \quad (2)$$

The time (with respect to J2000.0 epoch) and distance of the closest encounter are given by the formulas:

$$t_{XY}^{\min} = -\frac{\langle \vec{\mu}_{XY}, \vec{r}_{XY} \rangle \times c}{\|\vec{\mu}_{XY}\|^2} \text{ yr}, \quad (3)$$

$$d_{XY}^{\min} = \sqrt{d_{XY}^2 - \frac{\langle \vec{\mu}_{XY}, \vec{r}_{XY} \rangle^2}{\|\vec{\mu}_{XY}\|^2}} \text{ ly}, \quad (4)$$

where  $\langle \cdot, \cdot \rangle$  is the standard scalar product of vectors and  $c$  is the speed of light in km/s. Using these formulas, we obtain:

$$d_{XY}^{\min} = \mathbf{0.93} \pm 0.01 \text{ ly and } t_{XY}^{\min} = \mathbf{31.5} \pm 0.2 \text{ kyr} \quad (5)$$

for the closest encounter of  $\varepsilon$  Eri with Luyten 726-8. Actually, intermediate radial velocities (in the range from +22 to +29 km/s) for BL/UV

Ceti give even better results. For example, if  $v_{r,Y} = +25$  km/s then  $d_{XY}^{\min} \approx \mathbf{0.86}$  ly.

Finally, the duration of mutual transit  $\Delta t_{XY}^{(1\text{ly})}$  of two star systems within 1 ly from each other is given by the formula:

$$\Delta t_{XY}^{(1\text{ly})} = 2t_{XY}^{\min} \times \sqrt{\frac{1 - (d_{XY}^{\min})^2}{d_{XY}^2 - (d_{XY}^{\min})^2}} \text{ yr} \quad (6)$$

So, we get  $\Delta t_{XY}^{(1\text{ly})} \approx \mathbf{4.6}$  kyr from the main data and  $\Delta t_{XY}^{(1\text{ly})} \approx \mathbf{6.4}$  kyr if  $v_{r,Y} = +25$  km/s.

### 3 Discussion

This and other examples from our simulations show that stellar encounters within 1 ly might be more frequent than previously thought. It could explain peculiar trajectories of some stars, brown dwarves, planets and minor celestial bodies. For instance, Proxima's trajectory with respect to Alpha Centauri AB might be the result of one or several close encounters. Such encounters could even explain Sedna's trajectory in the solar system!

### 4 Acknowledgements

This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France.

### References

- [1] J.-M. Deltorn and P. Kalas. *Search for Nemesis encounters with Vega,  $\epsilon$  Eridani, and Fomalhaut*, volume 244 of *ASP Conference Series*, pages 227–232. San Fransisco: Astronomical Society of the Pacific, 2001.
- [2] G. Gontcharov. Pulkovo compilation of radial velocities for 35495 Hipparcos stars. *AL*, 32(11):759–771, 2006. *cf.* catalogue III/252 at SIMBAD.
- [3] S. Malaroda, S. Galliani, and H. Levato. *Bibliographic catalogue of stellar radial velocities (1999-2006.5)*. Complejo Astronomica el Leoncito (CASLEO), San Juan, Argentina, 2006. *cf.* catalogue III/249 at SIMBAD.
- [4] I. Potemine. Giant Nemesis candidate HD 107914 / HIP 60503 for the perforation of Oort cloud. *arXiv:1003.5308*, pages 1–3, 2010.
- [5] F. van Leeuwen. Validation of the new Hipparcos reduction. *A&A*, 474:653–664, 2007. *cf.* catalogue I/311 at SIMBAD.