Jets and ***Binary Systems*** - Image Processing

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Translated by Philippe Schuller.

Using image processing tools and a method (described elsewhere[1]), we show that certain jets are associated with binary systems and also that this phenomenon is observable not only within double stars but also on the scale of the cores of galaxies. We will consider first the case of the Crab (M1) pulsar, then that of the core of galaxy M87. We shall see thereby that the latter is a system of two interacting bodies. Please note that all the processed images are based on the best images, i.e. best resolution, available on internet.

M1 (the Crab nebula and its pulsar)

A little history,

In July of 1054, the Chinese astronomers observed the apparition of a new star. It was so bright that it was visible in broad daylight. A month later, it disappeared. In Europe, no mention was made of it. It wasn't until 1731 that John Bevis rediscovered it as a nebula. In September 1758 it was registered in the Messier catalogue as M1.

Properties,

Located at a distance of 6300 light years, in the Bull constellation, M1 is without doubt the most observed nebula, in all possible wave lengths. Its magnitude is –3.2 (1000 times more luminous than the sun). Its spread is presently 10 light years (6'x 4').

The simple (and simplified) death of a star,

The star then collapses, its gases plunge toward its core, then rebound violently, provoking a shock wave which ejects its corona (see the article "A propos de…supernovae" of Gérard Oudenot in l'astronomie of June 2003 p.264).

M1 would be the residue of a massive star, having 8 to 25 solar masses (it would thus be a type II supernova). Its spectrum shows hydrogen and other elements including oxygen.

There are numerous photographs of M1. We will consider one of them, fig.1, undoubtedly one of the best. Taken by ESO at the VLT, it is outstanding due to its technical characteristics (its resolution), but also by its beauty.

Fig. 1 (ESO – VLT)
http://www.eso.org/outreach/press-rel/pr-1999/pr-17-99.html

There is another document containing striking characteristics (fig.2). It is a sequence of 33 short-exposure images (1ms) of the central pulsar and of another star, obtained by NOAO, taken with the photon counting camera KPCA[2].

These images are presented here as published by NOAO, therefore without any processing on my part.

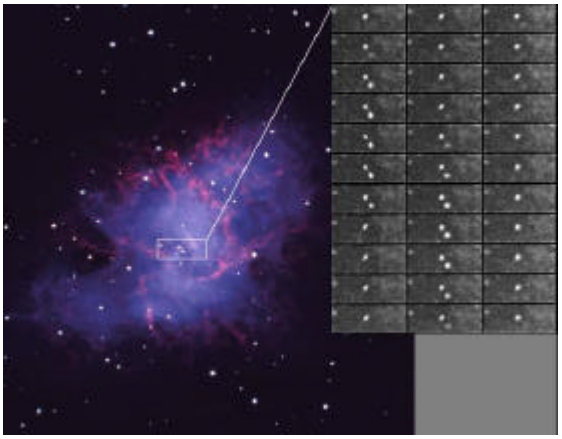

Fig. 2 NOAO (Oct. 20. 1989)

http://www.noao.edu/image_gallery/html/im0565.html

Image B_{03} quasy OFF state

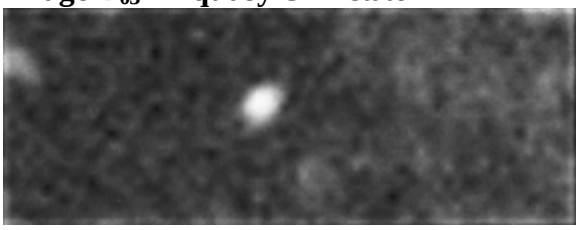

Fig. 3 (NOAO+KPCA)

Image A_{05} ON state

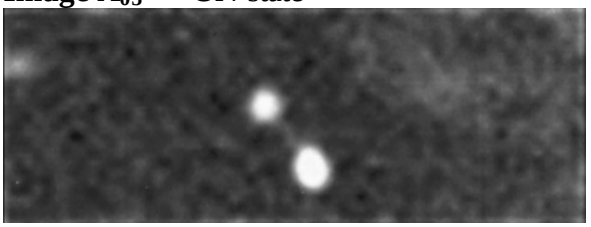

Fig. 4 (NOAO+KPCA)

A study of the sequence of the NOAO images with the KPCA camera (fig.2)

We identify the images of the sequence as per the following rules : from left to right, the columns A, B, C; from top to bottom, lines 0 to 10. Please note the chronological sequence is A0,1,2…, B0,1,2…, C0,1,2…

If one studies attentively the sequence, there is a troubling fact : in certain images, the pulsar seems connected to its neighboring star by a "luminous bridge". Is it an artifact due to noise from the camera? Or is it some other artifact? This luminous bridge appears only during the ON state of the pulsar, i.e. at its maximum burst, (fig.3), never at its OFF state (fig.4). This seems to eliminate the possibility of an artifact due to noise from the camera. But other causes are possible. To make sure, we have to look for other documents where the bridge is visible.

Study of a high resolution image obtained by NOAO

NOAO has produced another excellent photograph (fig.5) of the Crab nebula. We processed the pulsar region, indicated by a rectangle, with Photoshop[3], with the function "Image, Tuning, Curves (fig.6).

The result is clear : a bridge of light appears in red between the pulsar and its companion star (fig.7). Note that the bridge extends beyond the pulsar in the form of a jet.

Fig. 5 NOAO

http://www.noao.edu/image_gallery/html/im0466.html

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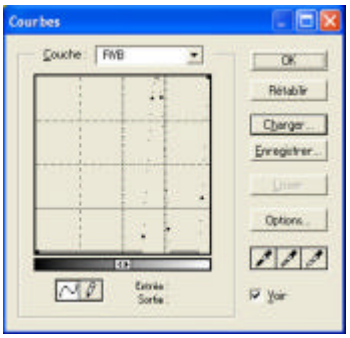

Fig. 6

http://perso.wanadoo.fr/lemprl/CRV_&_MAP/crab1_tiff_T1.CRV

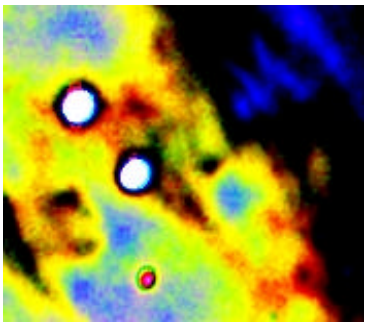

Fig. 7 DP Image.

http://perso.wanadoo.fr/lempel/pulsar_crab1_noao.jpg

With a similar program for image processing, Ulead PhotoImpact[4] (Format, Map of shades), one obtains exactly the same result (fig.8). This allows us to rule out any effects due to a specific computer program.

http://perso.wanadoo.fr/lempel/CRV_&_MAP/crab1_tiff_T1.MAP

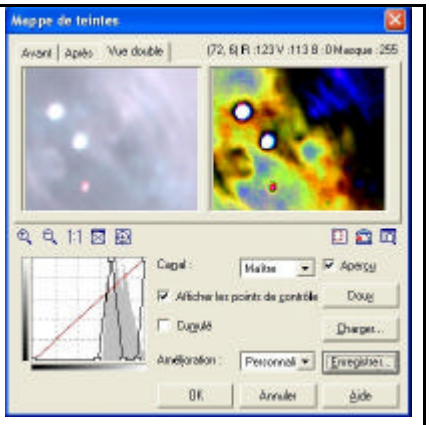

Fig. 8

Study of an image obtained by ESO at the VLT

Produced by ESO at the VLT, this high resolution image of the central region of the Crab (fig.9) is processed similarly to the preceding image (fig.10 and 11), notwithstanding a few defects (vertical streaks).

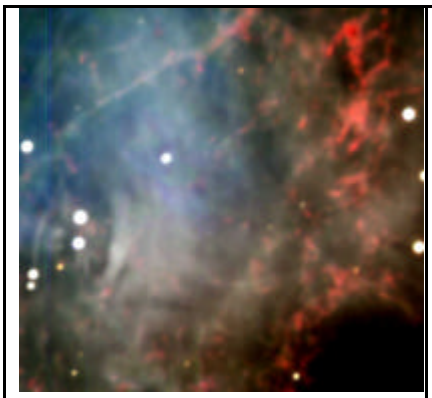

Fig. 9 (ESO – VLT)

http://www.eso.org/outreach/press-rel/pr-2000/pr-01-01

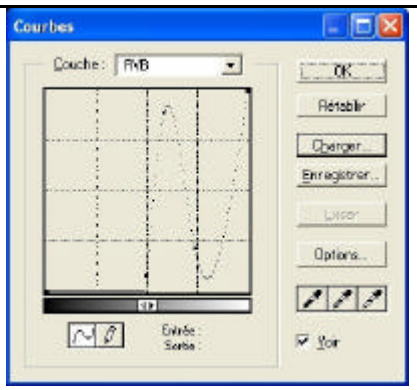

Fig. 10

http://perso.wanadoo.fr/lempel/CRV_&MAP/Crab_01.CRV

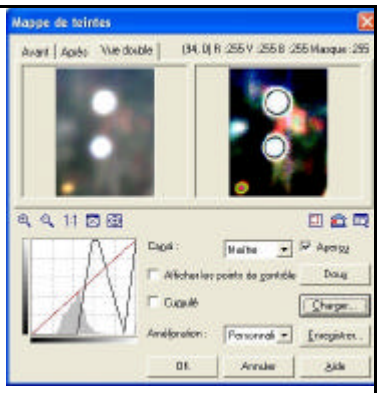

Fig. 11

http://perso.wanadoo.fr/lempel/CRV_&_MAP/phot-04b-00b_jpg_01.MAP

The two treatments, by Photoshop (fig.10) and by Ulead Phootoimpact (fig.11) yield the same result (fig.12). The bridge appears, here also, very clearly. One can also see, at the bottom, the beginning of a jet. On the left of fig.9, there is a second system of double stars, connected by a luminous bridge with a jet extension. There is no need for any processing. This system is perfectly visible in the original image. Nevertheless, for curiosity's sake, we made an image processing of it also (fig.13).

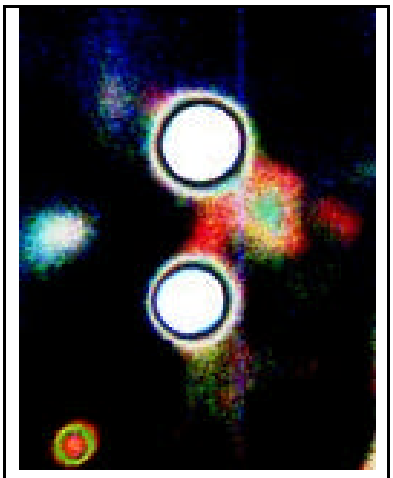

Fig. 12

http://perso.wanadoo.fr/lempel/phot-04b-00_pulsar_T_01s2.jpg

Conclusions for M1

2 – The luminous bridge and the jet are brought out by different computer programs, in three documents coming from different sources using different instruments. It is therefore not an artifact.

3 – While the periodical functioning of the jet is shown in only one document (KPCA), the fact that it appears only when the pulsar is ON and never when OFF, allows one to conclude that this is a real phenomenon.

4 – This luminous bridge would be periodic and in phase with the pulsar. We are thus considering a different mechanism than the one generally invoked to explain the phenomena of pulsars and their associated jets.

5 – By extension, might there be jets in systems of double massive bodies, such as black holes, which seem to exist in various galactic cores?

http://perso.wanadoo.fr/lempel/phot-04b-00_frag_&_T_01.jpg

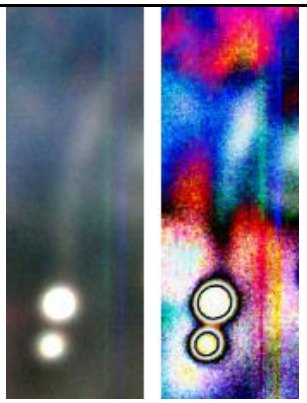

Fig. 13

M87 (The galaxy and its core

M87 (fig.14) is a gigantic elliptic galaxy located 60 million light years away in the Virgo cluster of galaxies. Its apparent diameter is 120 000 light years, its mass is 10^{12} solar masses, its absolute magnitude –22. It has two exceptional properties : a system of more than 4000 globular clusters, and especially a very high velocity spectacular straight jet, 5000 light years long, discovered in 1918. Its light is very polarized and has the characteristics of synchrotron radiation. The jet appears blue on the short light exposures.

http://www.aao.gov.au/images/captions/aat053.html

Fig. 14 (AAO)

It is a violent and turbulent phenomenon. Its aspect appears mashed up at the high resolutions of HST (fig.15). Recent observations have shown the violent activity of the galaxy core, revealing the presence of a massive object of 2.5 billion solar masses, concentrated within a sphere having a radius of 60 light years. ESO published on internet the first VLT images during the first semester of 1998. Some of them show a jet issuing from the galaxy core (fig.16).

http://hubblesite.org/newscenter/archiv/2000/20/

Fig. 15 (HST)

ESO gives the following information in a commentary of this photograph :

VLT UT1 First Light Photo No.7 *"This image is a color composite of three images taken in ultraviolet, blue and visible light (U, B and V filters) during the night of May 25-26, 1998. In reality, the bright blue color of the jet corresponds to ultraviolet radiation. The atmospheric conditions were less than optimal during this exposure."*

We do not know anything more; the first impression one gets is of a spoiled photograph, especially as compared with the HST photograph. In fact, it is impossible to compare the two photographs. The scales are so different. The HST one covers a square approx. 10 000 light years on a side, while the VLT one covers a rectangle approx. 150 x 250 light years. As for M1, processing with either Photoshop (fig.17) or PhotoImpact yields the same surprising image (fig.18). A complementary analysis of the ESO image allows us to eliminate the possibility of an artifact due to the processing. We note the following facts :

- a blue ring (a doughnut) surrounds the central object (green);
- the jet issues from the ring, in its plane and toward a second object (green);
- after having circumvented this second object, the jet continues further out.

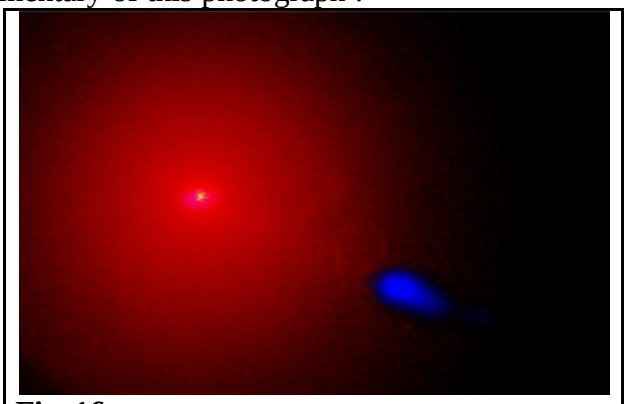

Fig. 16 http://www.eso.org/outreach/info-events/ut1fl-03-07-hires.jpg

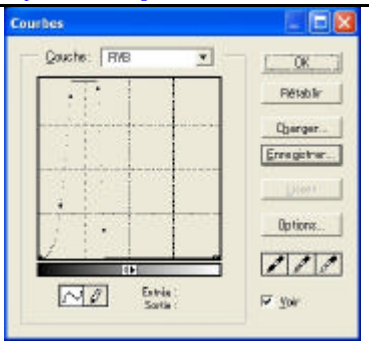

Fig. 17 http://perso.wanadoo.fr/lempel/CRV_&_MAP/M87_04.CRV

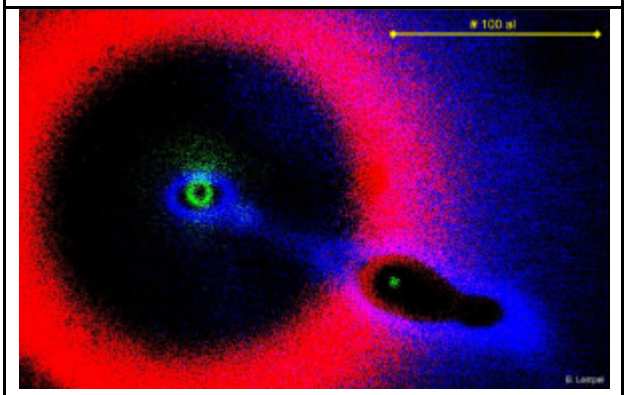

Fig. 18 http://perso.wanadoo.fr/lempel/m87_vlt_2.jpg

Conclusions for M87

We do not have presently any other data to confirm this result.

But if it is not an artifact, then there would exist in the core of M87 two massive bodies connected by a jet. The similarity with the mechanisms of the solar wind in interaction with the terrestrial magnetosphere (fig.19) is so great that it is difficult not to consider that these two bodies are interacting in the same way.

General conclusion

We have at our disposal three documents which show the existence in M1 of a star and a pulsar connected by a jet, and a document which shows tke presence of two massive bodies in M87 connected by a jet. This would be apparently an asymmetric phenomenon related to the presence of pairs of highly magnetized massive bodies in a highly ionized plasma atmosphere.
In both cases, new ideas are needed to explain the structure and the physics of these phenomena.

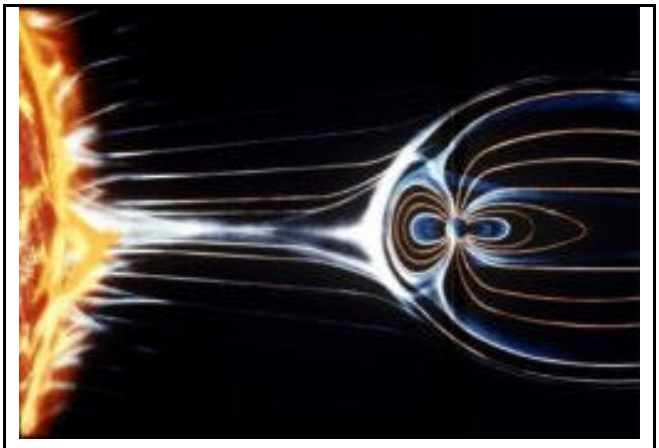

Fig. 19 http://science.mfsc.nasa.gov/newhome/headlines/ast28oct98_htm

Acknowledgements

To all those who, in their various functions, have participated in this effort. And especially Mr.Jean-Claude Pecker, Mr.Claude Picard and the editing team. And not forgetting Arlette, my wife, for her patience and her encouragement.

1. http://perso.wanadoo.fr/lempel/methodes_logicielles.pdf
2. PASP, vol 104, n°674, Avril 1992, p 263-269. Millisecond time resolution with the Kitt 6 – Peak Photon Counting Array (Sharp, N.A.)
3. http://www.adobe.com/support/downloads/product.jsp ?product=41&platform=win
4. http://www.uleadd.co.uk/fr/