

Astronomical HBT interferometry: inside-out femtoscscopy?

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- 2 Fake Proxima Centauri
- 3 Fraunhofer's Ghost
- 4 MAGIC SII
- 5 Watch this Space. . .

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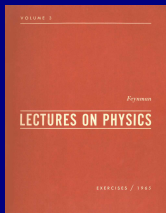
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Some astrophysical processes to image

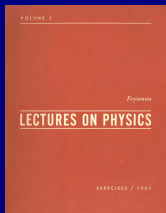
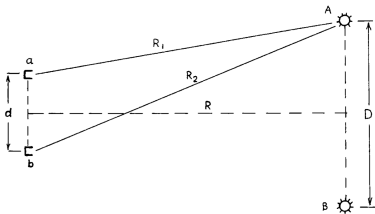
What is HBT really?



- 3-9. The diameter of the nearest stars is too small to be "seen" with the best telescopes (the angle subtended is less than the resolution of the telescope). The diameter of a star was first measured by Michelson using an optical interferometer. The method just barely works for the nearest stars. In 1956 Brown and Twiss (*Nature* 178, 1046, (1956)) proposed a new method, called "intensity correlation," for such measurements, and tested their method on the star Sirius. They took two parabolic reflectors (old searchlight mirrors) each with a photomultiplier tube at the focus. The outputs of the multipliers were fed by coax cables to a circuit that measured the average value of the product of the two currents (a so-called "correlator"). From the variation of this product with the separation of the two mirrors they determined the angle subtended by the star.

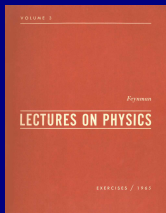
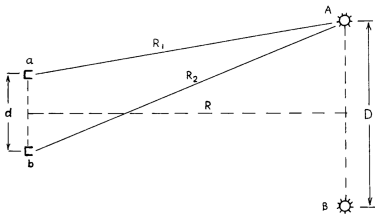
What is HBT really?

There were at the time many physicists who said that the method couldn't work. The argument was that since light came in photons which went either to one mirror or the other, there could be no correlation in the two currents. You can show that this argument is wrong by considering the following idealized experiment. There are two small sources -- say two light bulbs -- A and B, at a large distance from two photomultiplier tubes a and b with the geometry shown in the figure.



What is HBT really?

There were at the time many physicists who said that the method couldn't work. The argument was that since light came in photons which went either to one mirror or the other, there could be no correlation in the two currents. You can show that this argument is wrong by considering the following idealized experiment. There are two small sources -- say two light bulbs -- A and B, at a large distance from two photomultiplier tubes a and b with the geometry shown in the figure.



$$P(a, b) = \int_{A, B} |\langle a|A\rangle\langle b|B\rangle \pm \langle a|B\rangle\langle b|A\rangle|^2$$

Fake Proxima Centauri



Etienne KLEIN 
@EtienneKlein · [Follow](#)



Photo de Proxima du Centaure, l'étoile la plus proche du Soleil, située à 4,2 année-lumière de nous. Elle a été prise par le JWST. Ce niveau de détails... Un nouveau monde se dévoile jour après jour.

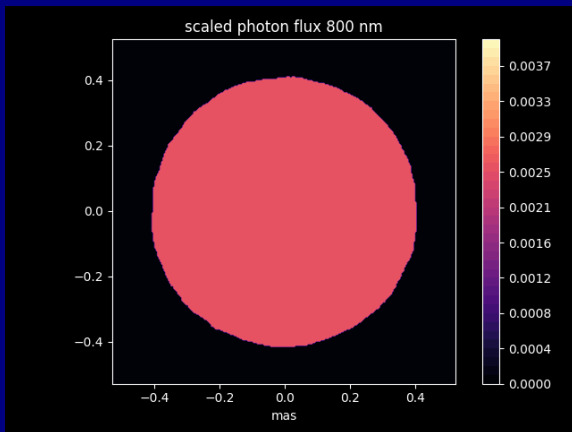


3:33 PM · Jul 31, 2022

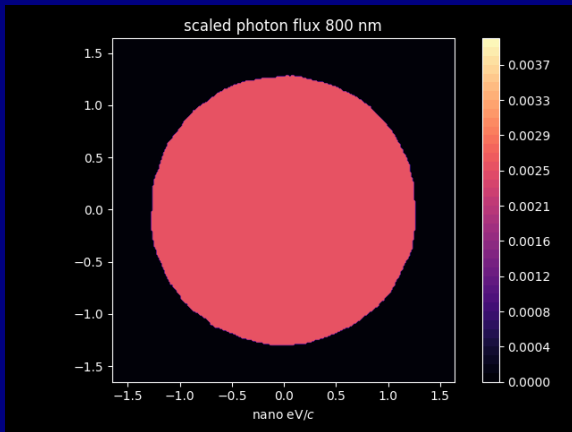


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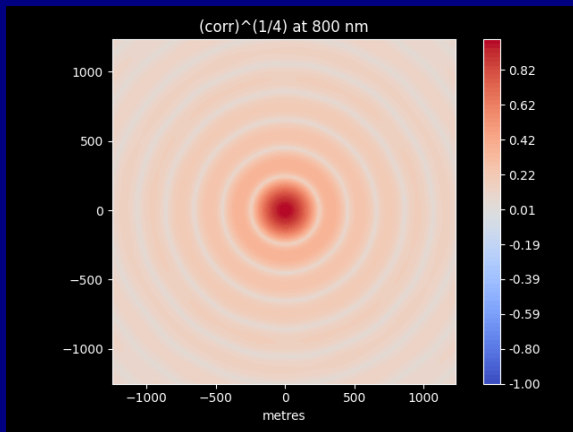
Fake Proxima Centauri



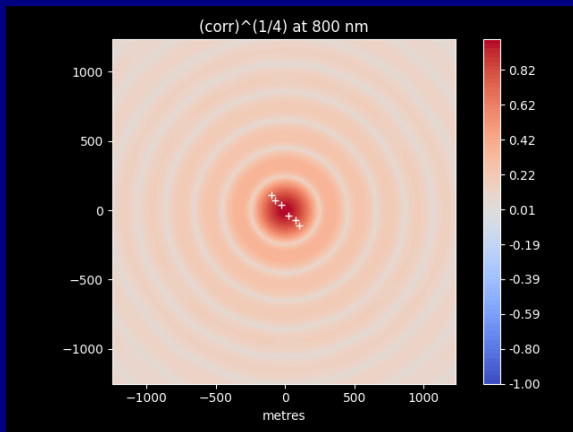
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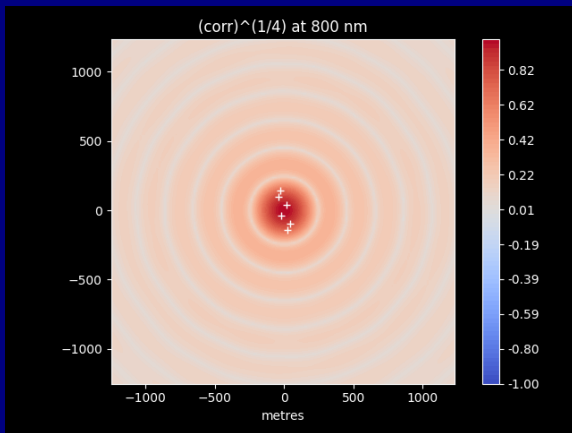
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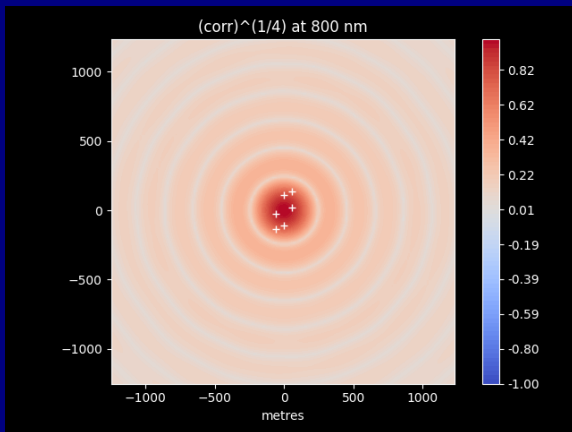
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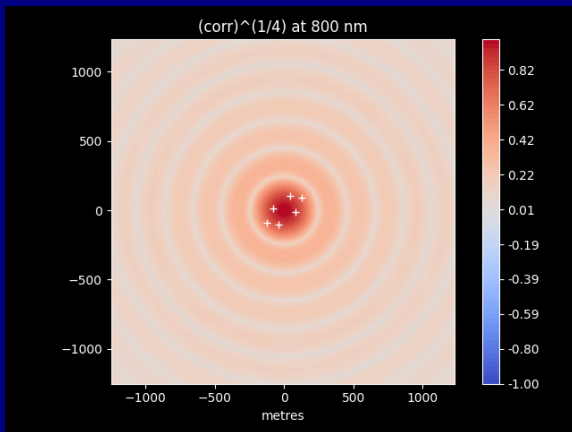
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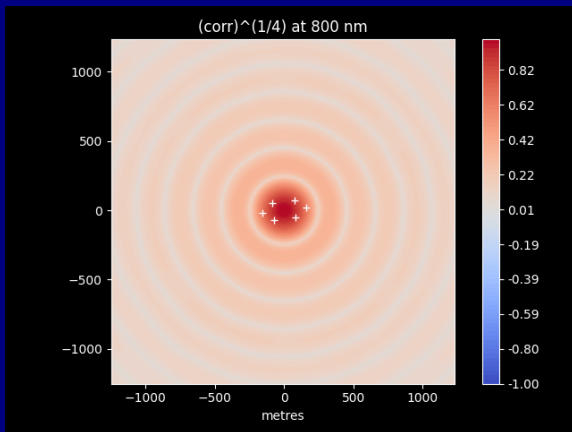
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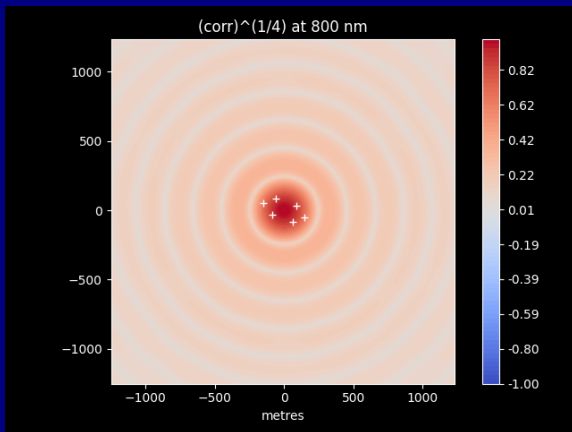
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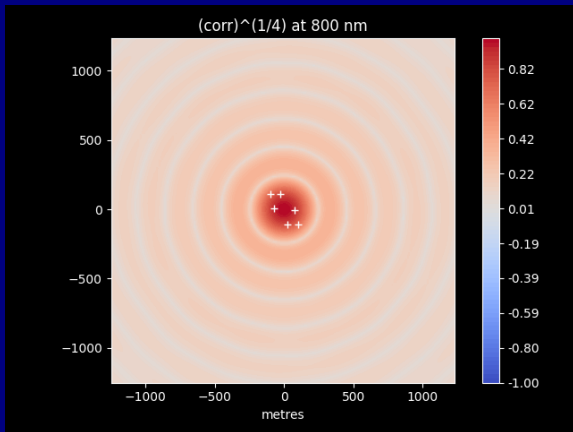
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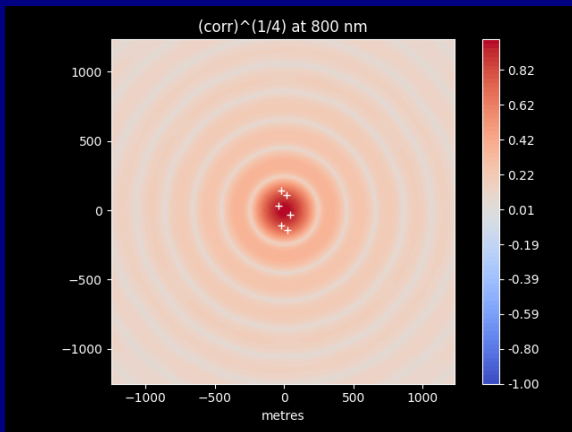
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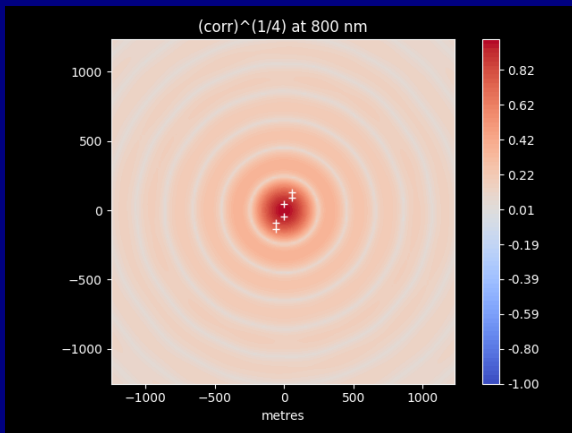
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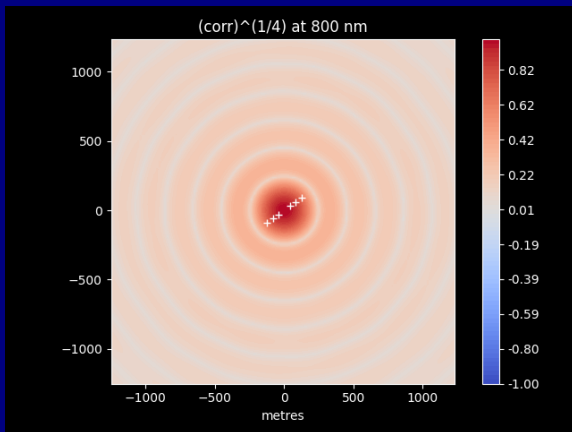
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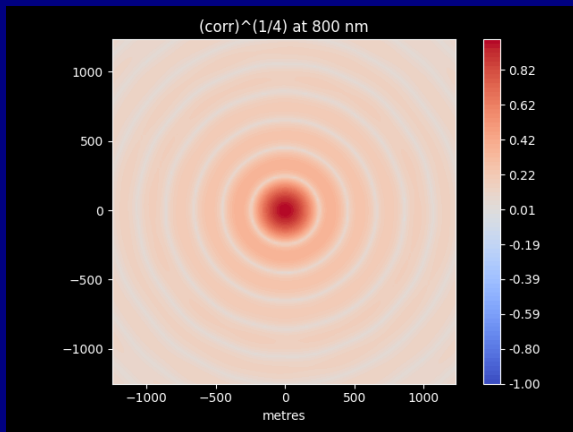
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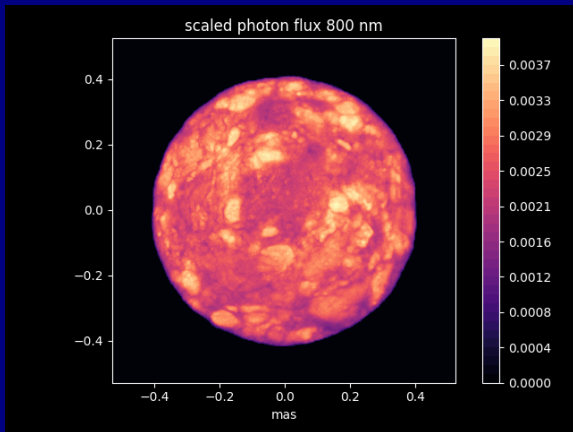
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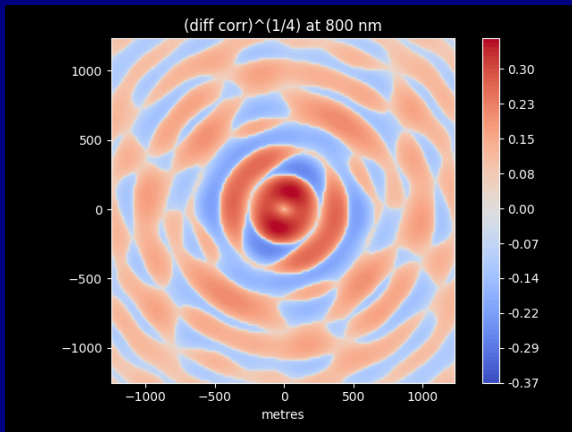
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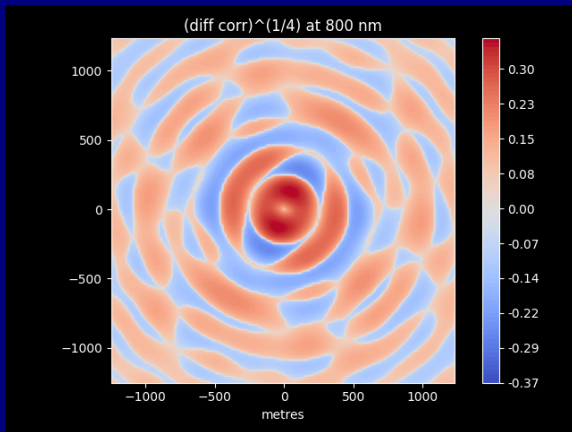
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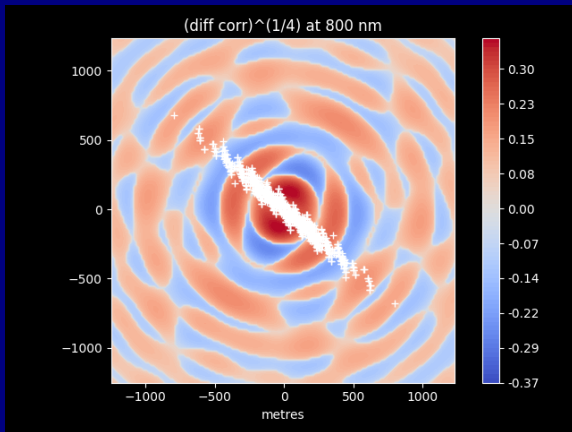
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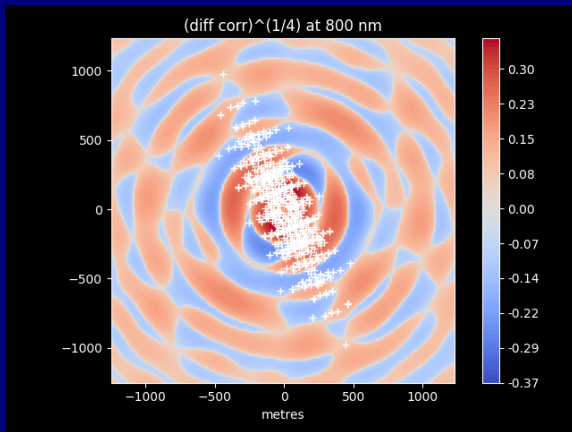
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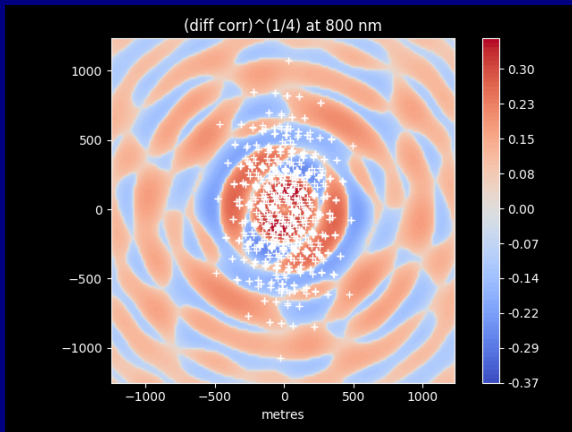
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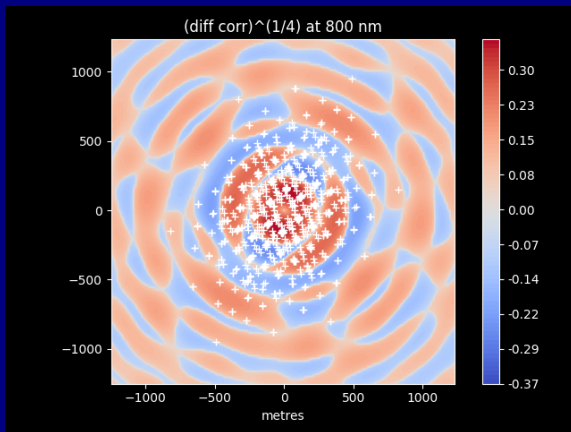
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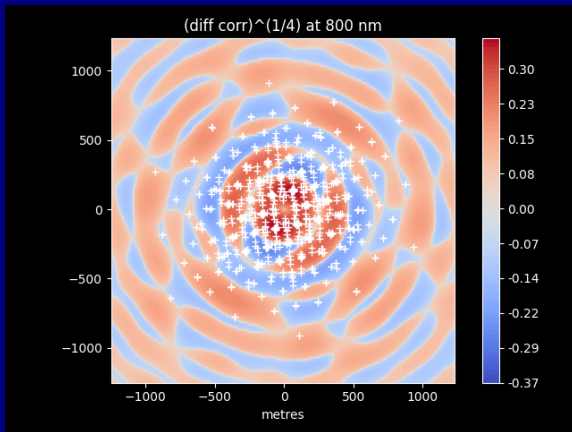
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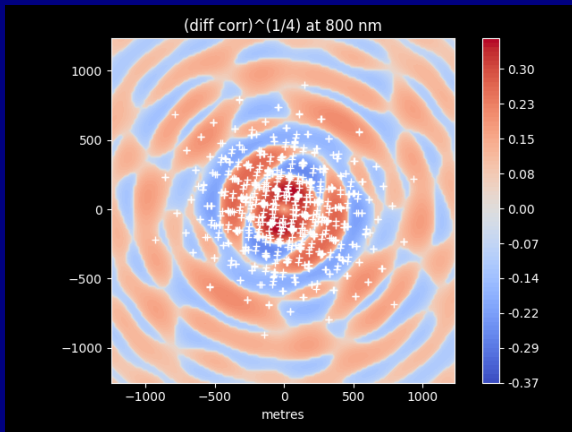
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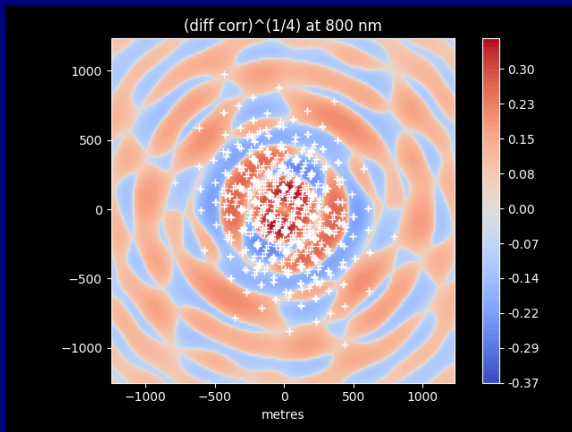
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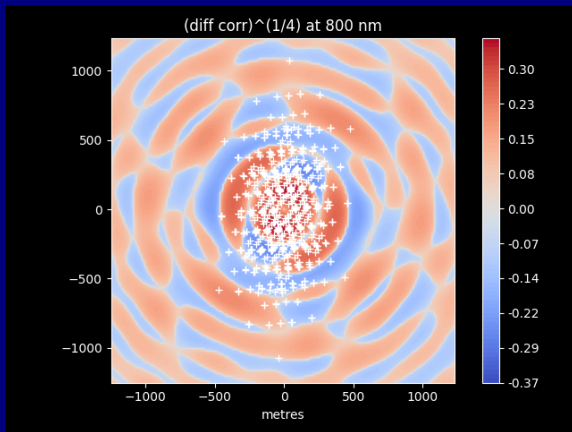
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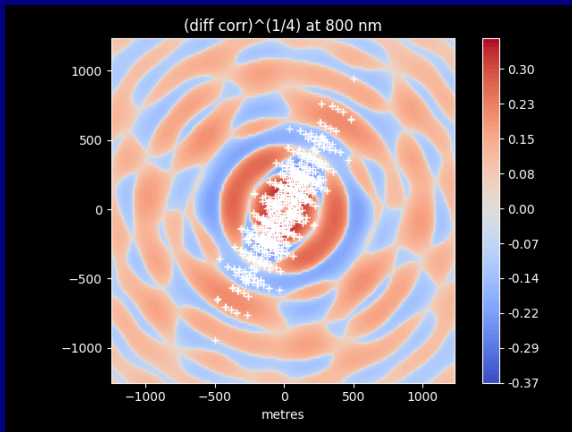
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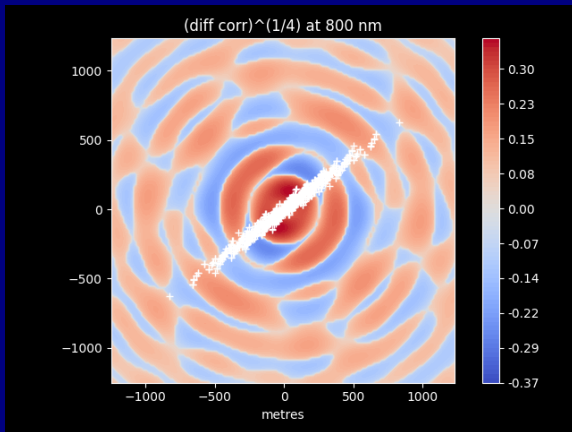
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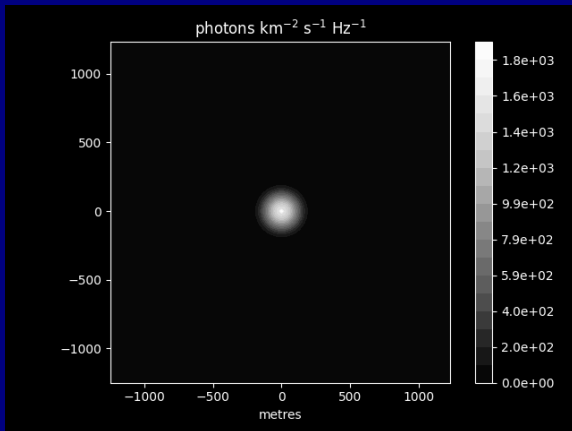
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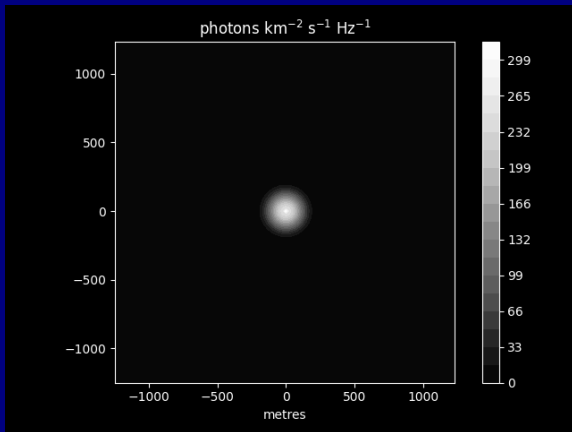
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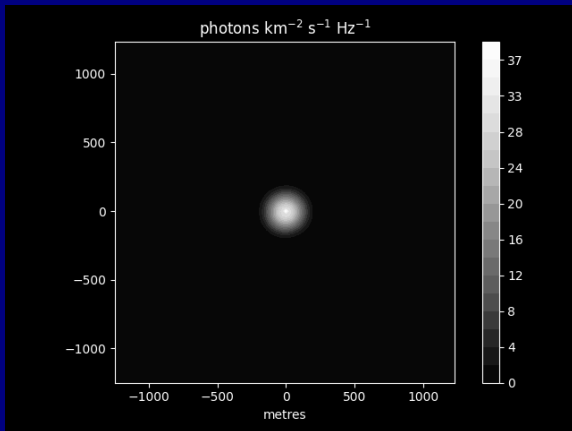
Fraunhofer's Ghost



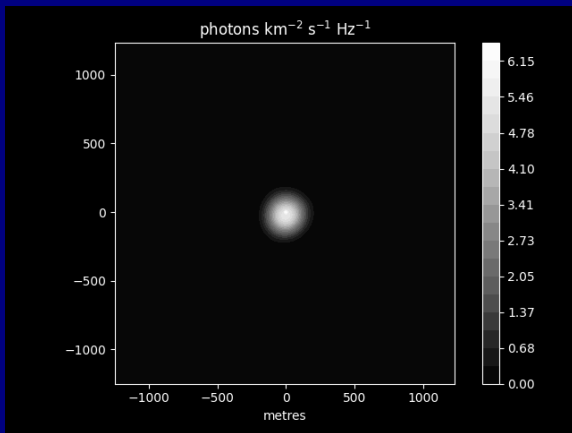
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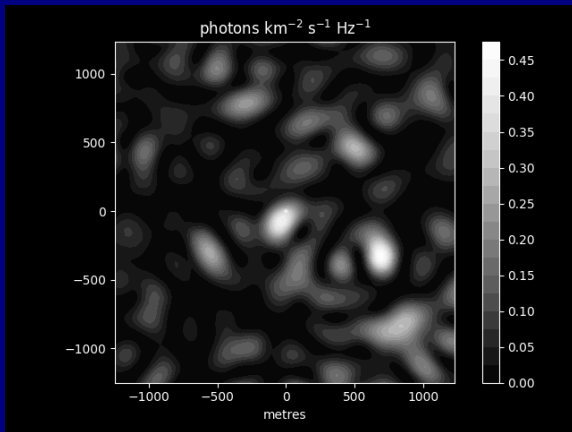
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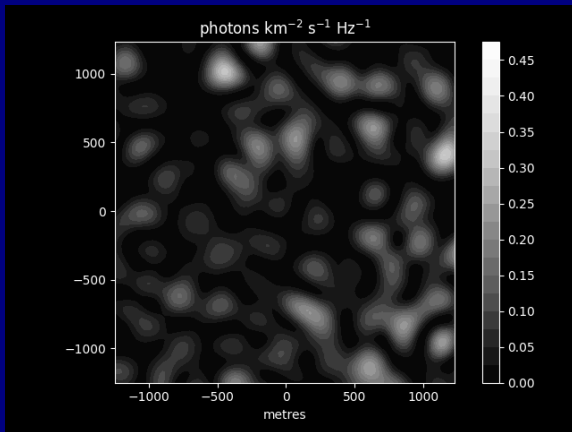
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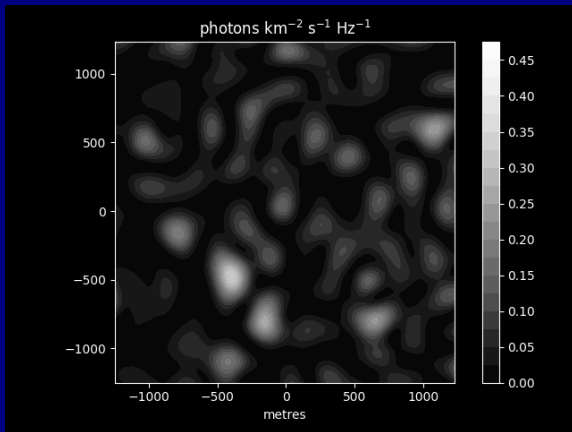
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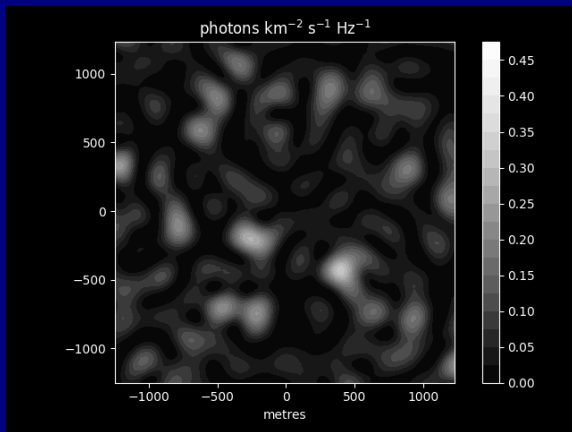
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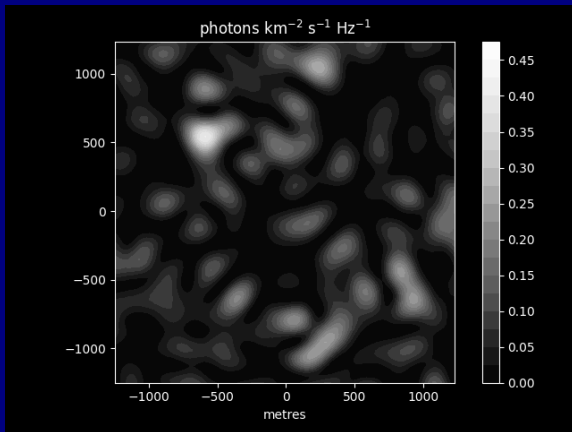
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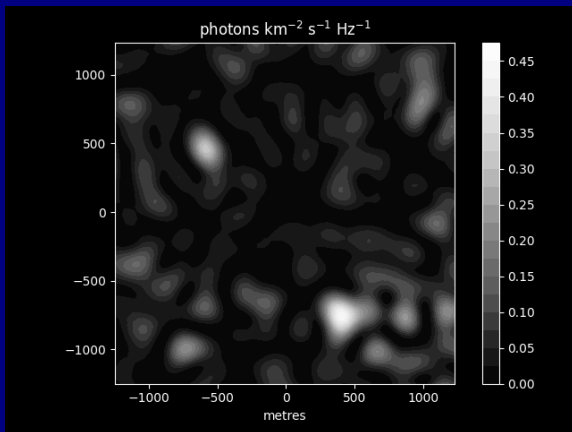
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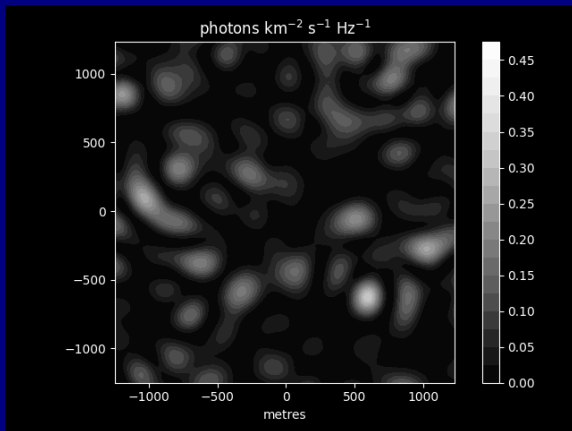
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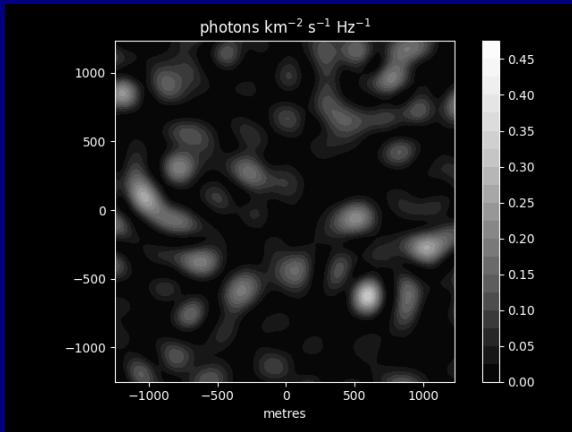
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Fraunhofer's Ghost

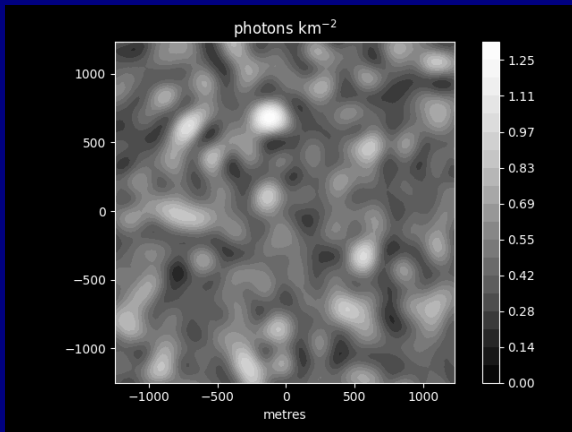


Fraunhofer's Ghost

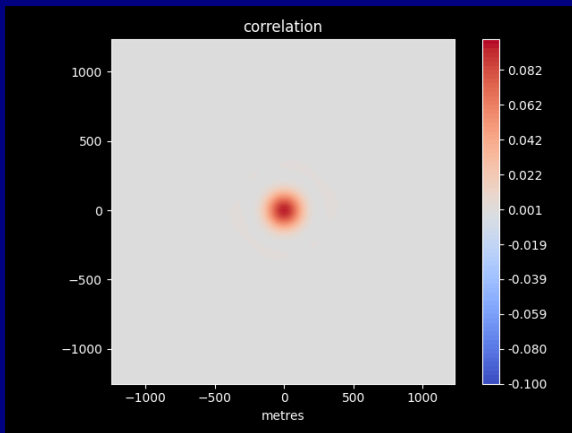


Now let's sum over 10 coherence times . . .

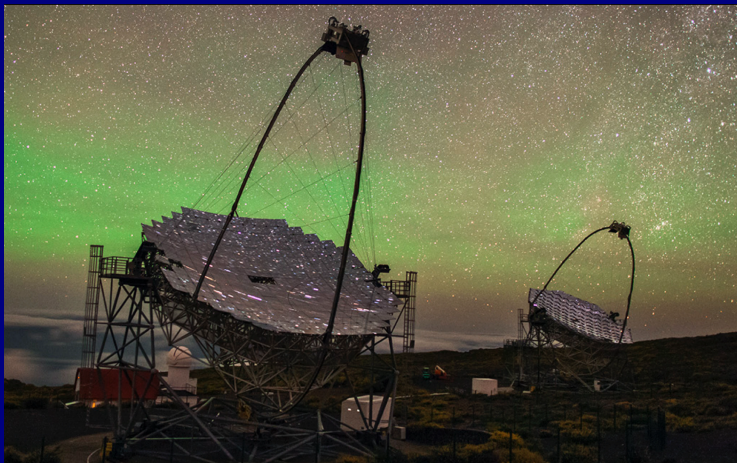
Fraunhofer's Ghost



Fraunhofer's Ghost

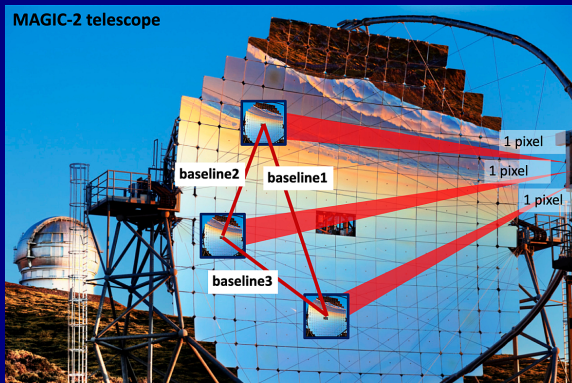


MAGIC



MAGIC

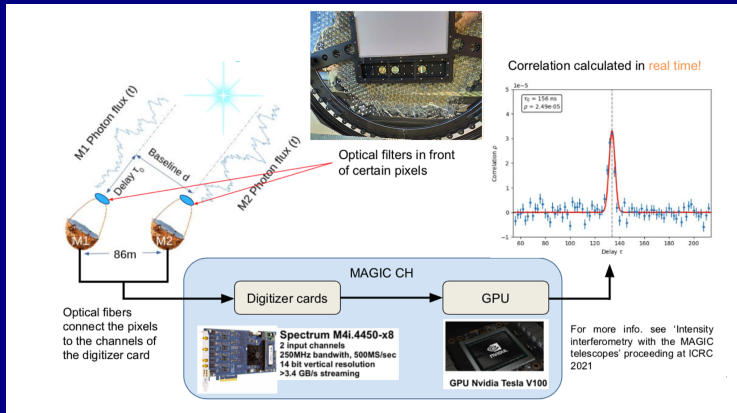
MAGIC-2 telescope



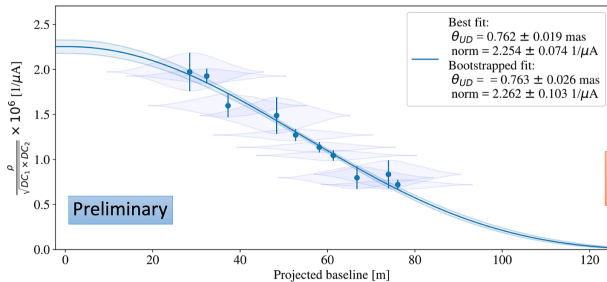
MAGIC SII



MAGIC SII

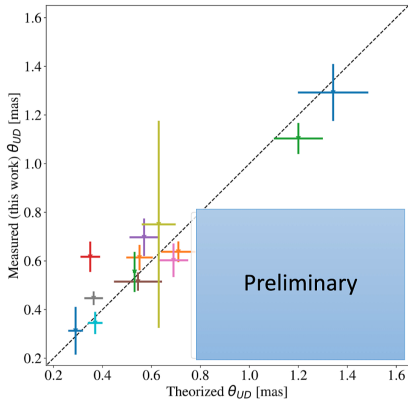


MAGIC SII



T. Hassan
I. Jiménez
(CIEMAT)

MAGIC SII



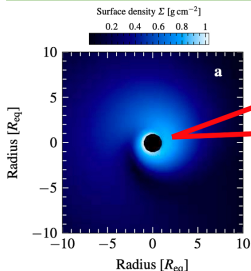
Draft almost ready!

Watch this Space...

Be stars or WR stars

- Stars with a slow outflow (“decretion disk”).
- Strong emission in $H\alpha$ and $H\beta$ emission lines.

Model of Be star with decretion disk



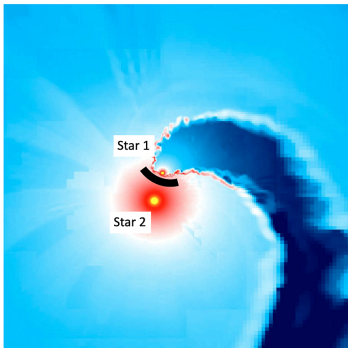
Rivinius et al, arXiv:1310.3962

Spectrum of Be star γ Cas



Watch this Space. . .

Colliding wind binaries



Cyg OB 9, simulation of bow shock.

Credit: Australian National Univ./E. R. Parkin and Univ. of Liege/E. Gosset

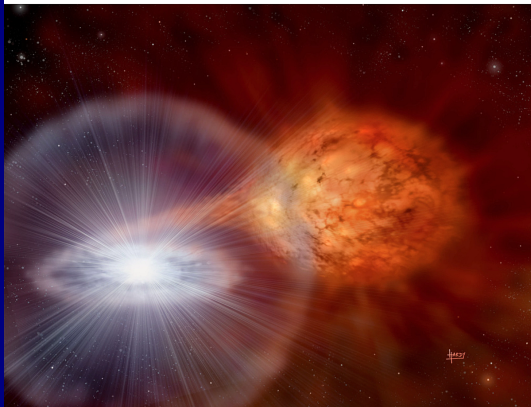
HE and VHE γ -ray sources:

- **Eta Car**
- **γ^2 Velorum**

Both very bright in visible.

Watch this Space. . .

Newest type of VHE source: nOVas



Recurrent nova RS Oph
detected at VHE:

- ▶ H.E.S.S., Science, 376-6588 (2022) 77
- ▶ MAGIC, Nat. Astr. 6 (2022) 689