Fifty years of High Time Resolution Astrophysics at La Silla : results and prospects

Christian Gouiffès
Département d'Astrophysique, CEA- Saclay, France
christian.gouiffes@cea.fr

Fifty years of High Time Resolution Astrophysics at La Silla : results and prospects

Christian Gouiffès
Département d'Astrophysique, CEA- Saclay, France
christian.gouiffes@cea.fr

With inputs from C. Barbieri, P. Bouchet, G. Kannbach, C. Motch, H. Pedersen, A. Shearer

Fifty years of High Time Resolution Astrophysics at La Silla : results and prospects

Christian Gouiffès
Département d'Astrophysique, CEA- Saclay, France
christian.gouiffes@cea.fr

With inputs from C. Barbieri, P. Bouchet, G. Kannbach, C. Motch, H. Pedersen, A. Shearer

Special thanks to the dedicated (and enthousiastic !) effort by J. Alonso, E. Barrios, F. Guttierez, N. Haddad, B. Jansson, M. Maugis, R. Rojas, P. Le Saux, P. Sinclaire …

Another special thanks

THE MESSENGER

EL MENSAJERO

No. 1 — May 1974

To All ESO Staff Members

A todo el personal de ESO

With this issue, we launch the ESO MESSENGER in its orbit in ESO, and wish it a fruitful mission. Its task will be, first of all, to promote the participation of ESO staff in what goes on in the Organization, especially at places of duty other than our own. Moreover, THE MESSENGER may serve to give the world outside some impression of what happens inside ESO.

The need for more internal communication within ESO is felt by many of the staff. The dispersion of our resources over several countries in widely separated continents demands a special effort to keep us aware of what is going on at the other establishments. Our tasks are always part of one large adventure that can fare well only if each of its components is healthily adjusted to the others.

The contents of THE MESSENGER will be varied to include occasional progress reports on our main projects as well as information on general developments and messages concerning personnel. This first issue may be taken as an indication of the character we have in mind, but clearly it will be only in the course of time that THE MESSENGER will find its proper shape. Time also will show how large the newsletter should be and how often it should appear. For the moment we think that three-month intervals will be about right. Certain articles for this first issue were obtained at a rather early stage in the preparations, but they are considered to be still of sufficient interest for inclusion.

Prof. A. Blaauw
Director-General, ESO

Con la presente edición estamos lanzando EL MENSAJERO ESO en su órbita y le deseamos una exitosa misión. Su objetivo será en primer lugar informar al personal de ESO sobre lo que sucede dentro de la Organización, especialmente en lugares distintos al propio lugar de trabajo. Además, EL MENSAJERO servirá para dar una impresión al mundo externo de lo que ocurre dentro de ESO.

Un gran número del personal de ESO ha sentido la necesidad de tener una mayor comunicación interna. Debido a la dispersión de nuestros recursos en varios países ubicados en distintos continentes se requiere un esfuerzo especial para informar sobre lo que sucede en los demás establecimientos. Nuestras tareas siempre forman parte de una gran aventura que sólo puede llegar a un feliz término si todos sus componentes se ajustan sanamente unas a otras.

En cuanto al contenido del MENSAJERO éste tendrá la suficiente variación como para incluir informes sobre el progreso de nuestros principales proyectos como también mensajes sobre el desarrollo en general y sobre el personal. Rogamos aceptar esta primera edición como una indicación sobre lo que estamos tratando de presentar, porque sólo con el transcurso del tiempo EL MENSAJERO encontrará la forma más apropiada. También sólo el tiempo demostrará el tamaño que deberá tener este informativo y la frecuencia con la cual deberá aparecer. Por el momento opinamos que una publicación trimestral es la más indicada. Algunos

1

High Time Resolution Astrophysics (HTRA, high speed photometry, fast photometry) :

- ✓ involves observations and studies of cosmic sources on timescales of seconds to sub-milliseconds
- ✓ informations on a larg variety of astronomical objects (from solar system bodies to the recently discovered Fast Radio Bursts)

- Binary Systems
- CVs
- LMXBs
- HMXBs
- Neutron Stars
- Pulsars, Magnetars, Isolated NS
- Normal Stars
- GRBs
- Asteroseismology
- Stellar Pulsations
- Brown Dwarfs
- Transients and Occulations
- AGN
- ……..

Mutual Phenomena :eclipses and occultations of the satellites by themselves
PHEMU85 at ESO, important campaign (part of a mundial effort), observations in high speed mode (50 msec) at the ESO50cm and ESO1 m

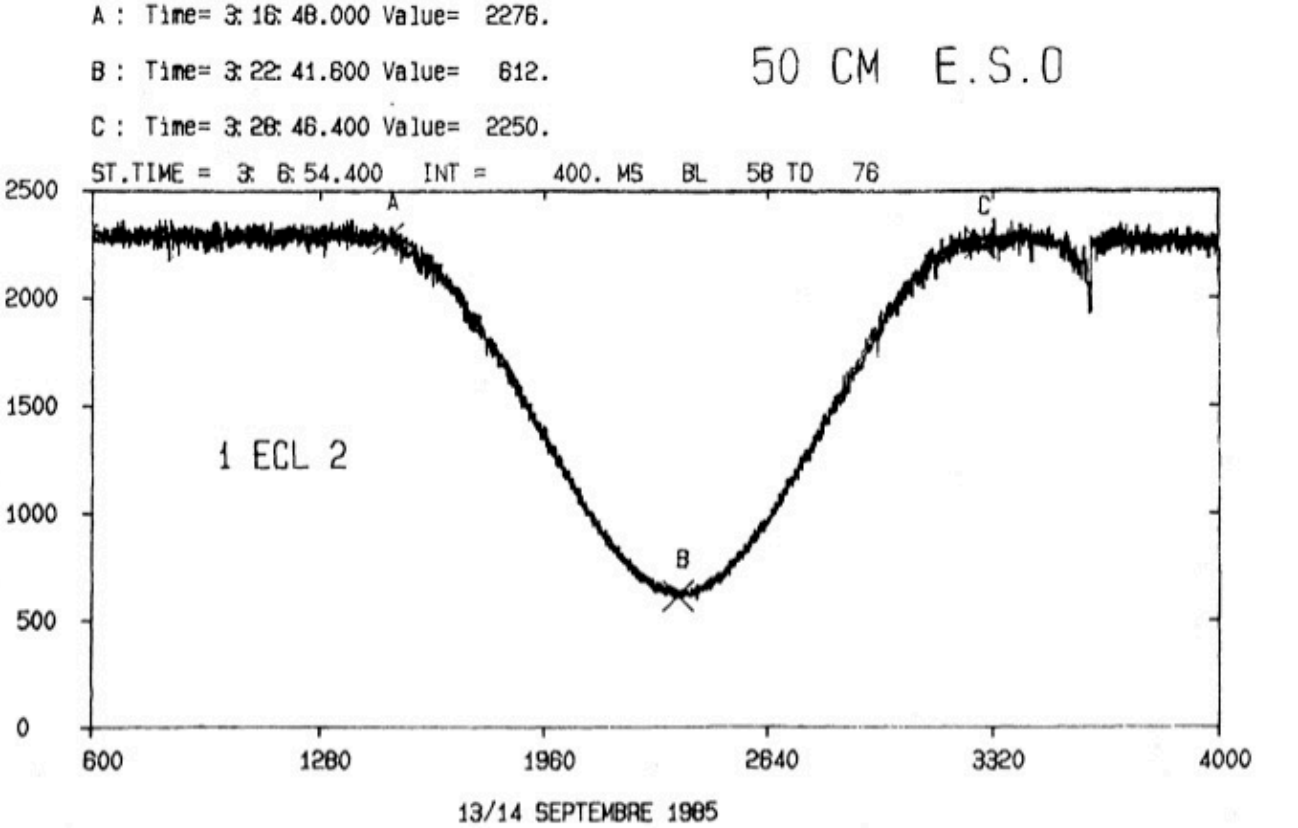
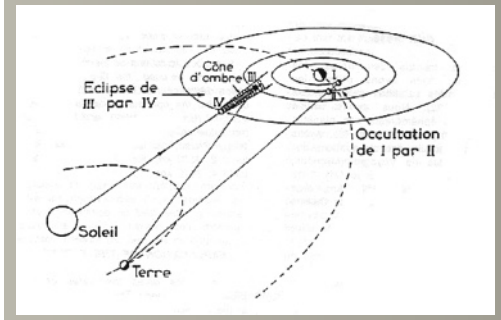


Figure 2: *IO (J1) eclipses EUROPA (J2) on September 13, 1985. The time unit on this picture is 400 ms, and 18 blocks have been added. The points A, B, C have been determined graphically through the reduction programme available at La Silla.*

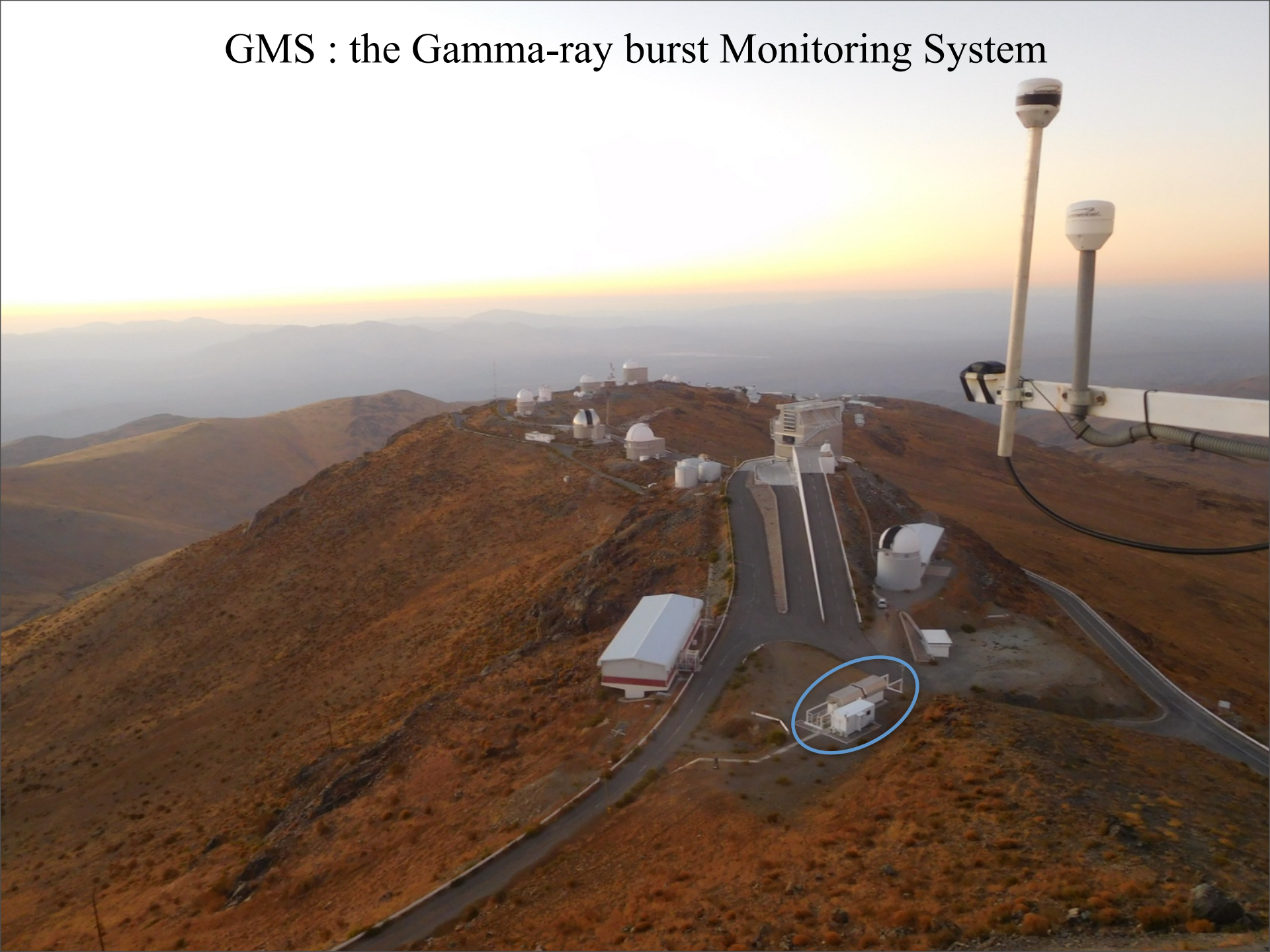


Successful campaign (even if Obs. during July-September, not the best period for photometric observations)

INFRARED (occultations of Uranus, Neptune and Europa)

1982Icar...52..454S : Sicardy, et al., 1982 : The 15 August 1980 occultation by the Uranian system - Structure of the rings and temperature of the upper atmosphere
1985LPICo.559...35H : Hubbard et al., 1985 : Occultation detection of a Neptune ring segment
1985LPI....16..368H : Hubbard et al., 1985 : Occultation Detection of a Neptune Ring Segment
1985Icar...64...88S : Sicardy et al., 1985 : Variations of the stratospheric temperature along the limb of Uranus - Results of the 22 April 1982 stellar occultation
1985JGRS...90...35H : Hubbard et al., 1985 : Occultation detection of a Neptune ring segment
1986Natur.320..729S : Sicardy et al., 1986 : More dark matter around Uranus and Neptune?
1986Natur.324..227L : Lellouch et al., 1986 : Occultation determination of Neptune's oblateness and stratospheric methane mixing ratio
1987Icar...72..635H : Hubbard et al., 1987 : Oblateness, radius, and mean stratospheric temperature of Neptune from the 1985 August 20 occultation
1988ApJ...325..490H : Hubbard et al., 1988 : Structure of scintillations in Neptune's occultation shadow
1994A&A...288..985R : Roques et al., 1994 : Neptune's upper stratosphere, 1983-1990: ground-based stellar occultation observations III. Temperature profiles

GMS : the Gamma-ray burst Monitoring System



LETTERS TO NATURE

Detection of possible optical flashes from the γ-ray burst source GBS0526−66

H. Pedersen*, J. Danziger*, K. Hurley†, G. Pizzichini‡, C. Motch§, S. Ilovaisky§, N. Gradmann‖, W. Brinkmann‖, G. Kanbach‖, E. Rieger‖, C. Reppin‖, W. Trumper‖ & N. Lund¶

* European Southern Observatory, Karl Schwarzschild-Strasse 2, D 8046 Garching bei Munchen, FRG
† Centre d'Etude Spatiale des Rayonnements, BP 4346, 31029 Toulouse Cedex, France
‡ Istituto TESRE/CNR, Via dei Castagnoli, 1, 40126 Bologna, Italy
§ Observatoire, 41 bis, Avenue de l'Observatoire, 25000 Besançon, France
‖ Max Planck Institut für Physik und Astrophysik, Institut für Extraterrestrische Physik, D 8046 Garching bei Munchen, FRG
¶ Danish Space Research Institute, Lundtoftevej 7, DK 2200 Lyngby, Denmark

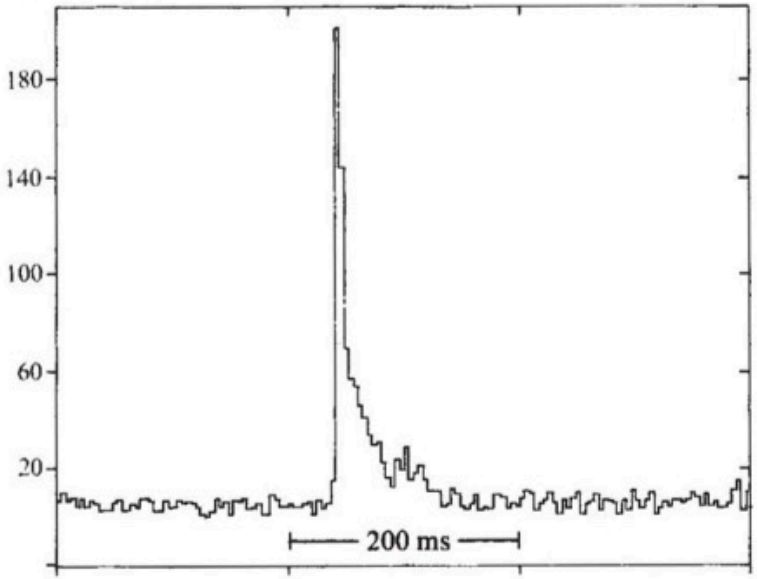


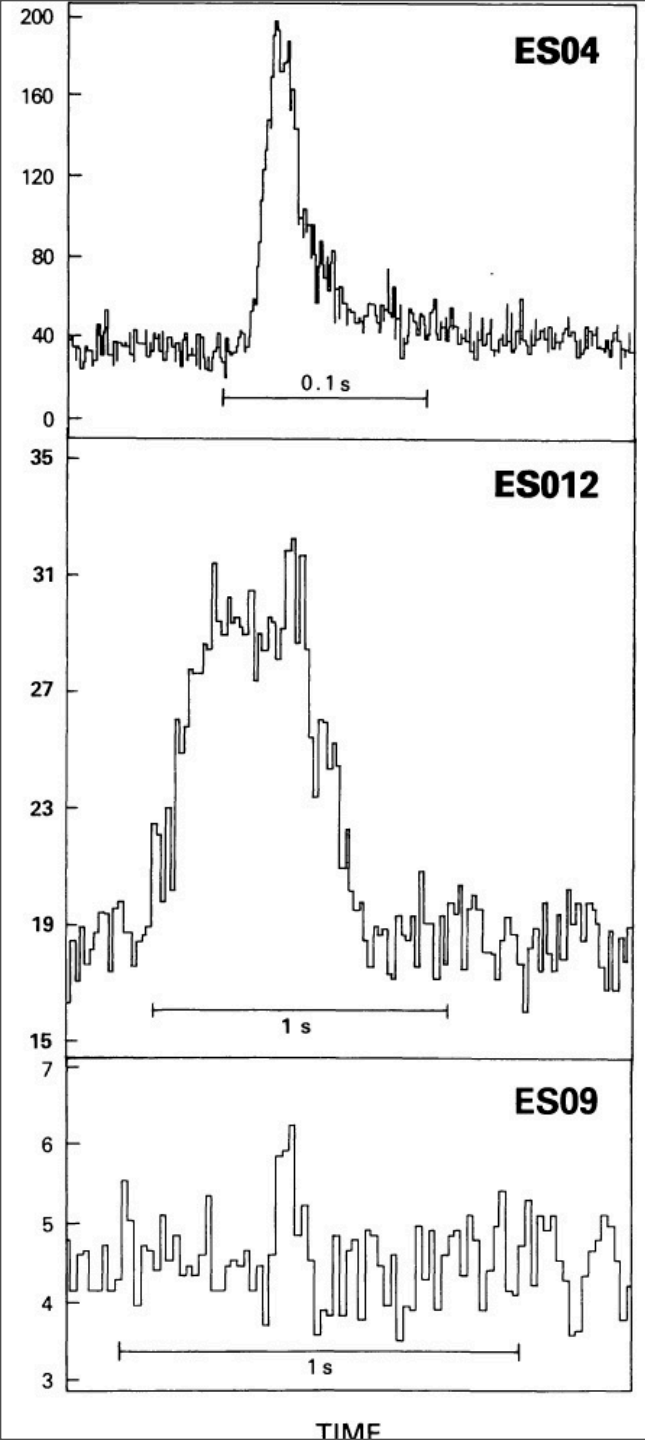
Fig. 1 An event observed 1983 October 27 UT 01:28. The time bin is 4 ms. Vertical axis corresponds to no. of counts, uncorrected for dark count or sky.

Photometric observations of the 1979 March 5 γ-ray burst

Pedersen et al, Nature, 1984

Observations at the ESO 50 cm + fast photometer

Ground-braking for GMS in 1983
Courtesy: Holger Pedersen



Optical flash background rates

B.E. Schaefer[1], H. Pedersen[2], C. Gouiffes[2], J.M. Poulsen[3], and G. Pizzichini[3]

[1] NASA/Goddard Space Flight Center, Code 661, Greenbelt, MD 20771, USA
[2] European Southern Observatory, Casilla 19001, Santiago 19, Chile
[3] TESRE/CNR, Via de Castagnoli 1, I-40126 Bologna, Italy

Schaefer et al, 1987, Astronomy and Astrophysics

Goal of the study : measure a flash background rate for comparison with Perdersen et al (1984)

- ✓ 49 flashes detected in 230 hours, mainly meteors and satellites passing through the field of view of the instrument
- ✓ No flashes similar in morphology on the N49 event of 1984 February 8

X-rays binaries and the multiwavelength campaigns

C. Motch et al.: Fast Optical Activity of GX 339-4

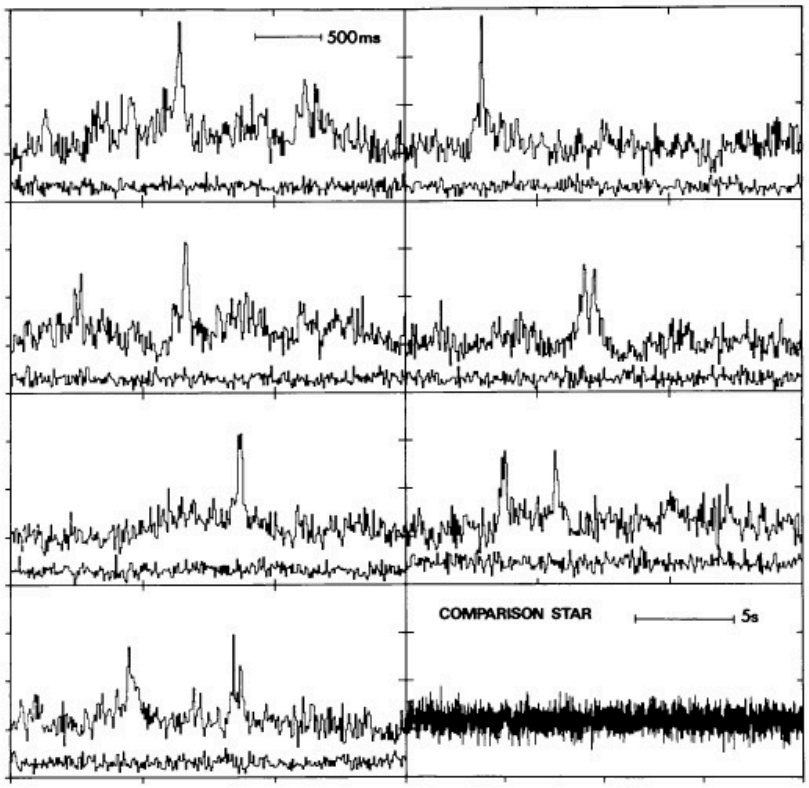


Fig. 3: A sample of flares picked up in data from the two nights with 10 ms resolution time. Sky data from the other channel are also plotted. The ordinate (count rate) ranges from 0 to 240. The data at the bottom right are from the comparison star allowing distinction between intrinsic activity and photon counting noise.

1.54Danish + 2 channel photometer, 10 msec time resolution

Motch et al, 1982

Letter to the Editor

Discovery of Optical Pulsations from 4U1626–67*

S. A. Ilovaisky[1,2], Ch. Motch[1], and C. Chevalier[1]

[1] LA 173, DAPHE, Observatoire de Paris-Meudon, F-92190 Meudon, France
[2] DPh-EP/SAp, CEN Saclay, B.P. No. 2, F-91190 Gif-sur-Yvette, France

Astron. Astrophys. 70, L19—L22 (1978)

ESO3.6m + 1 channel photometer built at Meudon, 100msec time resolution

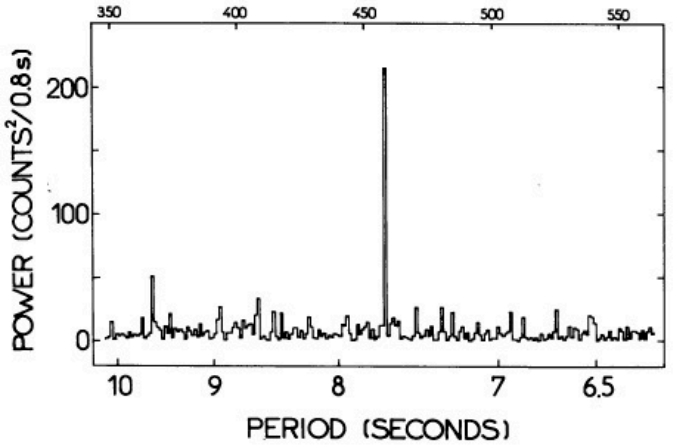


Figure 1. Power spectrum of the 4U1626-67 optical counterpart (Normalized power in counts²/0.8s vs. Period in seconds). Only the region from 0.1 to 0.16 Hz is shown for clarity. Power is the square of the half-amplitude of a sinusoidal signal. Numbers at the top identify individual Fourier frequency bins with n=1 for zero frequency.

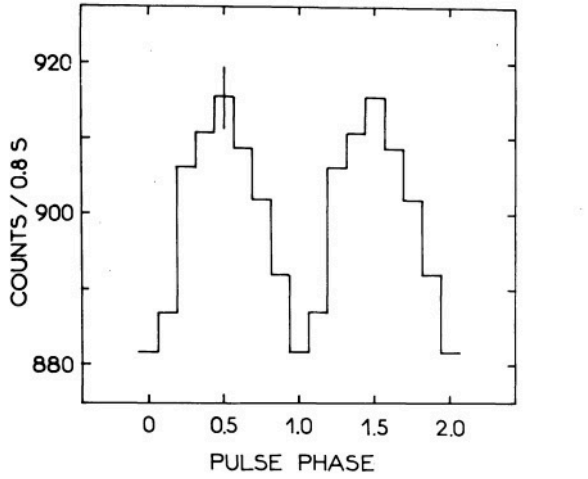


Figure 3. Pulsed light curve of the 4U1626-67 optical counterpart folded with a 7.6805 period and divided into 8 phase bins. Error bar is twice the standard deviation of counting rate means in the bins. Error bars derived from Poisson statistics are 30% smaller, due to the below-average quality of the night. Counts are given with sky substracted. The pulsed curve is shown twice for clarity.

Observation of GX 339-4 with the 1.54Danish + the ESO newly build 2 channel photometer, 10 msec time resolution

Acquisition and data analysis programmes written - after many efforts – in assembler by C. Motch and D. Hofstadt

C. Motch et al.: Fast Optical Activity of GX 339-4

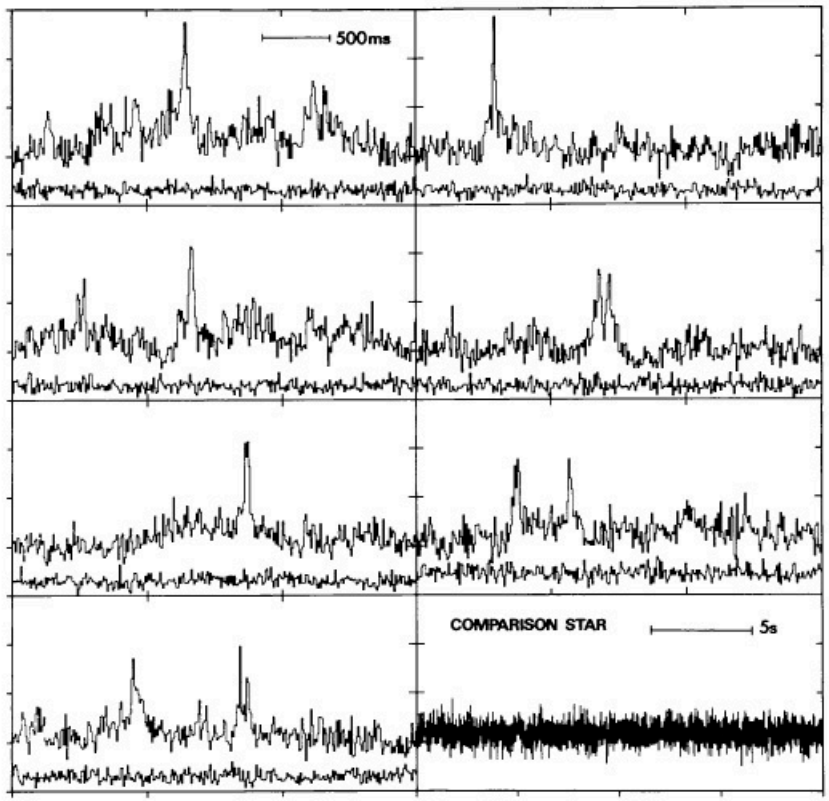


Fig. 3: A sample of flares picked up in data from the two nights with 10 ms resolution time. Sky data from the other channel are also plotted. The ordinate (count rate) ranges from 0 to 240. The data at the bottom right are from the comparison star allowing distinction between intrinsic activity and photon counting noise.

Motch et al, 1982

Simultaneous X-ray/optical observations of GX339-4 during the May 1981 optically bright state*

C. Motch[1], M. J. Ricketts[2], C. G. Page[2], S. A. Ilovaisky[3], and C. Chevalier[3]

[1] European Southern Observatory, D-8046 Garching bei München, Federal Republic of Germany
[2] Leicester University, University Road, Leicester LEI 7 RH, England
[3] Observatoire de Meudon, F-92190 Meudon, France

Astron. Astrophys. 119, 171–176 (1983)

Scientific interests of simultaneaous observations and discovery of their complicated organizations

Variations on different timescales show different behavior – correlation or anti correlation – depending of the energy of the X-rays photons

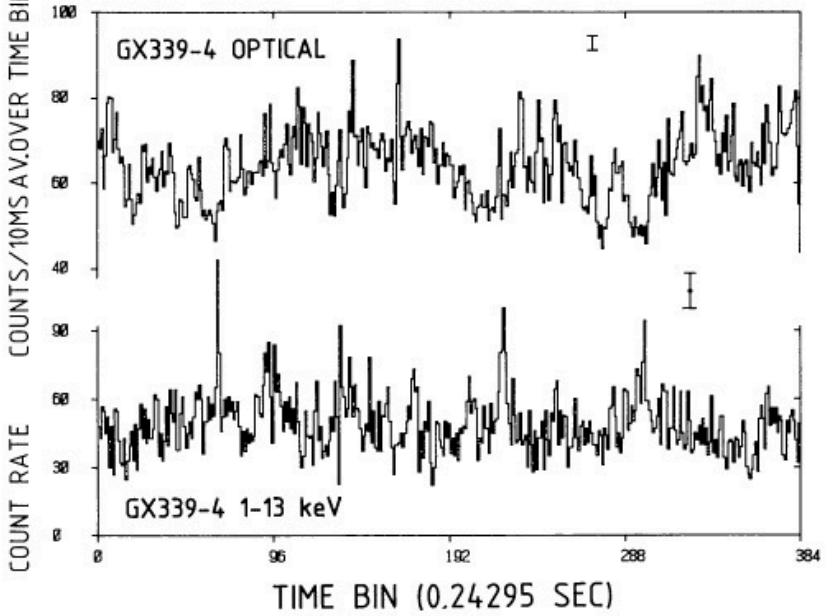
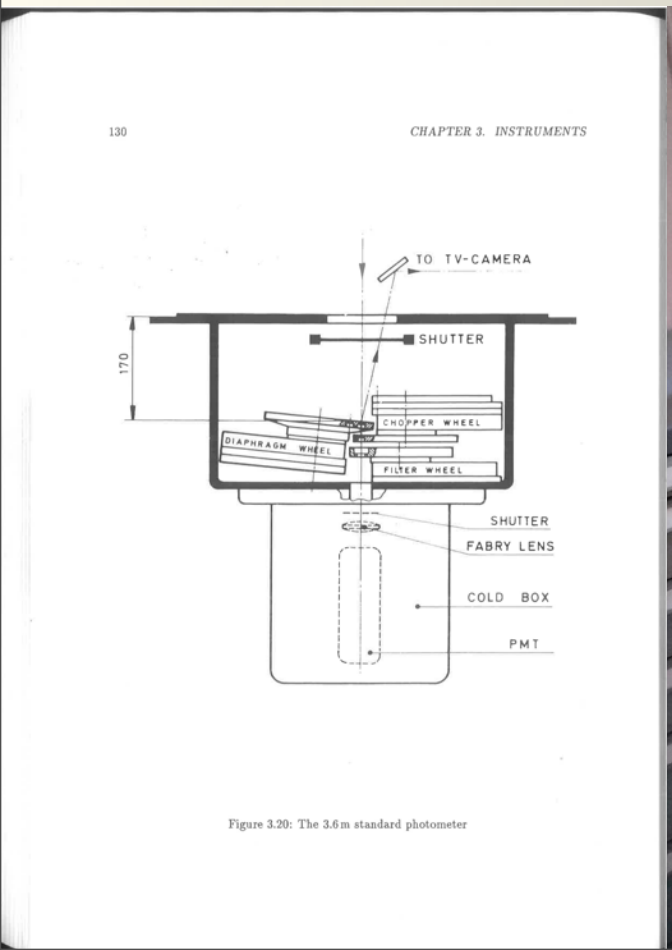


Fig. 1. Simultaneous X-ray and optical data plotted with 0.25 s resolution time. Typical $\pm 1\sigma$ error bars are indicated. Note the simultaneity between X-ray flares and optical dips

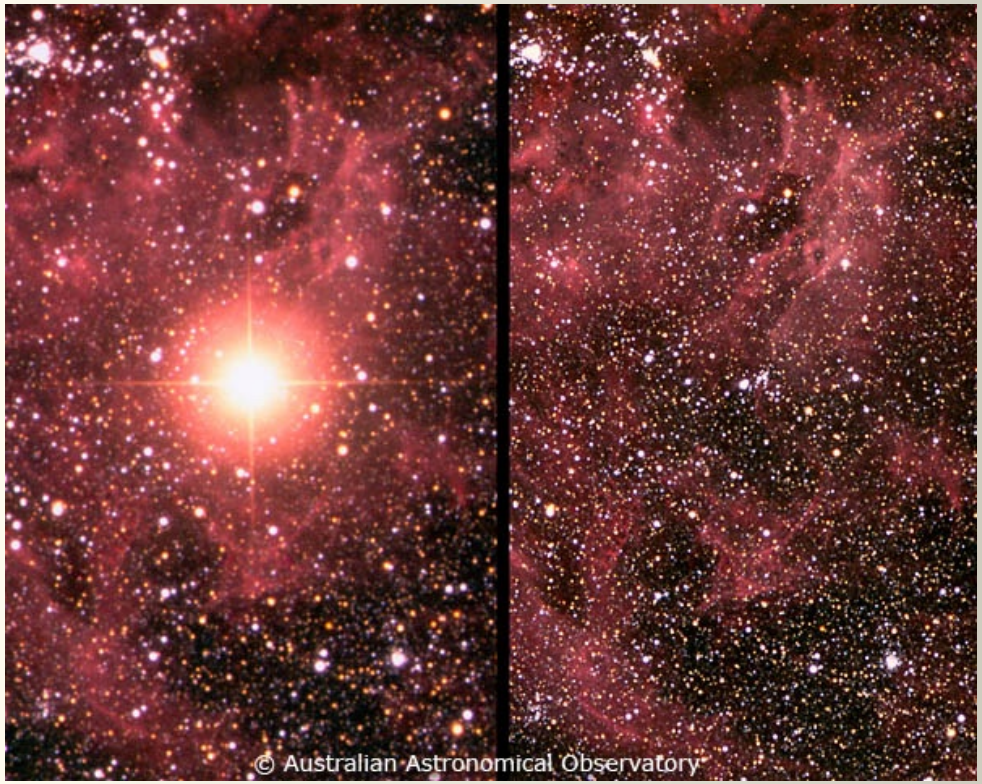
High time resolution of fast rotating compact objects : the search and studies of pulsars at the 3.6m telescope + the Fast Photometer

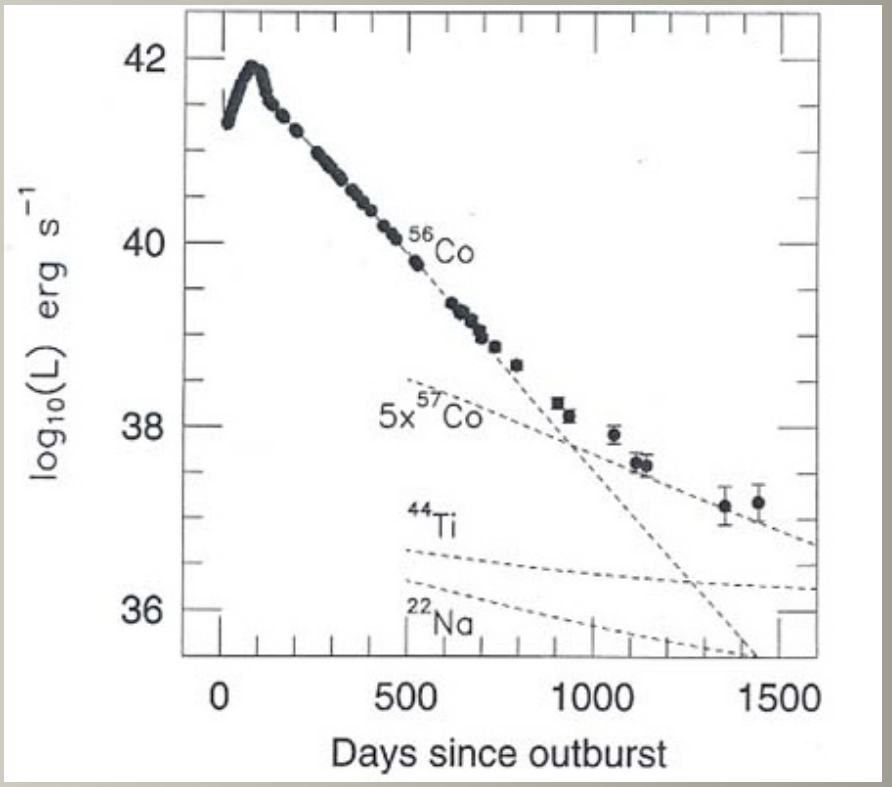
The ESO 3.6m photometer



High time resolution observation of SN1987A at La Silla from the beginning (ESO1m, 1.54D and then at the 3.6m telescope)

Regular observations of SN1987A with the goal to detect the birth of a pulsar





See Patrice Bouchet's talk on Friday

A project in close collaboration with Hakki Ögelman (MPE)

Circular No. 4735
Central Bureau for Astronomical Telegrams
INTERNATIONAL ASTRONOMICAL UNION
Postal Address: Central Bureau for Astronomical Telegrams
Smithsonian Astrophysical Observatory, Cambridge, MA 02138, U.S.A.
Telephone 617-495-7244/7440/7444 (for emergency use only)
TWX 710-320-6842 ASTROGRAM CAM EASYLINK 62794505
MARSDEN or GREEN@CFA.BITNET MARSDEN or GREEN@CFAPS2.SPAN

SUB-MILLISECOND OPTICAL PULSAR IN SUPERNOVA 1987A

J. Middleditch, Los Alamos National Laboratory; C. Pennypacker, D. E. Morris, R. A. Muller, S. Perlmutter, and T. Sasseen, Lawrence Berkeley Laboratory; J. A. Kristian and W.E. Kunkel, Mount Wilson and Las Campanas Observatories; M. A. Hamuy, Cerro Tololo Interamerican Observatory; J. N. Imamura, University of Oregon; T. Y. Steiman-Camero Ames Research Center, NASA; I. K. Shelton, University of Toronto; and I. R. Tuohy and S. Rawlings, Mt. Stromlo and Siding Spring Observatories, communicate: "We report observation of an optical pulsar in the supernova 1987A in the Large Magellanic Cloud. Detection was made at the Cerro Tololo 4-m telescope on Jan. 18, using a silicon photodiode with a sampling rate of 5 kHz. The magnitude of the pulsed light from the supernova changed continuously from mag 19 to 18 during a 7-hr period Jan. 18.1-18.3 UT. No pulsations were detected during a subsequent observation taken at the Las Campanas 2.5-m telescope on Jan. 31 in two 100-min runs with an upper limit of mag 20. The frequency of the pulsar during the Jan. 18 observation was tracked by dividing the data into independent half-hour runs; the statistical significance during these runs ranged from 11 to 37 standard deviations. The frequency exhibit a sinusoidal modulation; the 15 frequency measurements were within 5 percent (rms) of a sine function with a central value of 1968.629 Hz (barycentric), amplitude 3 x 10E-3 Hz (peak-to-peak) and period of 8 hr. Significant power was observed with the same sinusoidal modulation at the aliased frequencies for both the first and second harmonics."

1989 February 8 **(4735)** **Daniel W. E. Green**

And then came an IUA Circular

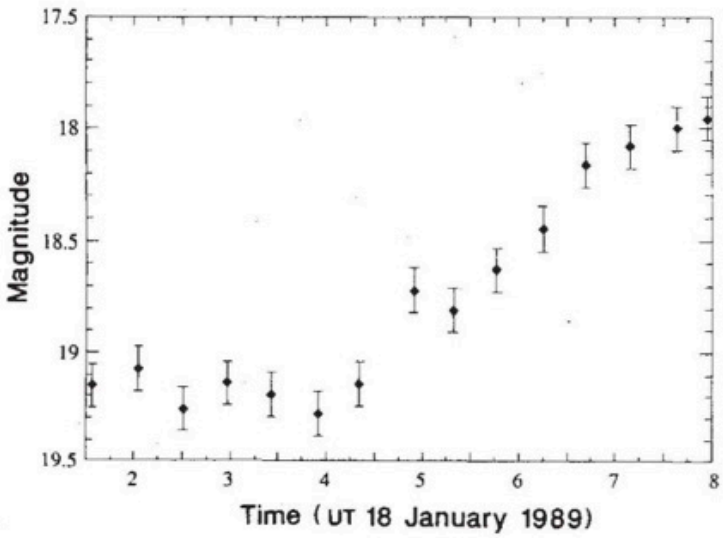


FIG. 2 Magnitude versus time for the 1,968-Hz fundamental frequency, for the same run as in Fig. 1. In addition to the uncertainties shown, there may be a systematic uncertainty of ±0.5 magnitude for each point.

Kristian et al, 1989, Nature

The ESO-3.6m 1989 SN1987A pulsar fever

- Crisis (but not Panic - just a bit -) after our Tololo's friends announcement
- → To compete, we had to change (quicky) the acquisition programme from 1kHz to 10kHz : a challenge brilliantly raised by the La Silla staff (Thanks again to all of them).
- Data written on magnetic tape = 1.8h of data/magnetic tape
- Intensive use of the ESO diplomatic bag

- IBM computer at MPE-Garching to run the analysis (a quick look was done at La Silla nearly in ''real time'')

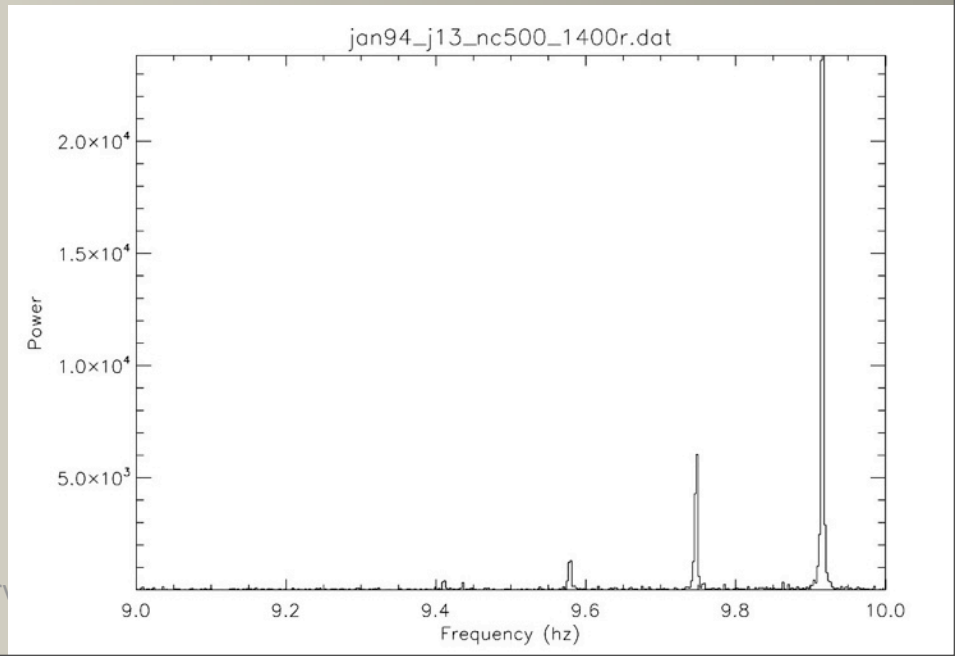
Circular No. 4743
Central Bureau for Astronomical Telegrams
INTERNATIONAL ASTRONOMICAL UNION
Postal Address: Central Bureau for Astronomical Telegrams
Smithsonian Astrophysical Observatory, Cambridge, MA 02138, U.S.A.
Telephone 617-495-7244/7440/7444 (for emergency use only)
TWX 710-320-6842 ASTROGRAM CAM EASYLINK 62794505
MARSDEN or GREEN@CFA.BITNET MARSDEN or GREEN@CFAPS2.SPAN

SUPERNOVA 1987A IN THE LARGE MAGELLANIC CLOUD

H. Ogelman, G. Hasinger, and W. Pietsch, Max-Planck-Institut fur Extraterrestrische Physik; C. Gouiffes, J. Melnick, T. Augusteijn F. Gutierrez, P. Grosbol, and C. Santini, European Southern Observatory; and H. Pedersen, Nordic Optical Telescope Scientific Association, communicate: "We have observed SN 1987A at a 10-kHz sampling rate with the ESO 3.6-m telescope on Feb. 15.06-15.25 and 16.08-16.17 UT with a range of filters covering the 0.4- to 0.9-micron band in an attempt to detect the 1968.629-Hz periodicity reported by Middleditch et al. (IAUC 4735). We see no significant signal within 20 Hz of the reported frequency in any of the 30-min averages of 17 Fourier transforms of 105 s. The implied upper limit to the pulsed flux for each interval is about 8 magnitudes less than the supernova itself. In a narrower search range, 1968.63 +/- 0.02 Hz, the 90-percent-confidence upper limit to the two-night average of the pulsed flux is 9 magnitudes less than the supernova. For a 1-hr exposure with the V filter on Feb. 16.06, the limit is mag 20.3 in the above narrow frequency range. The Fourier spacing of all transforms was about a factor of six larger than the amplitude of the reported 8-hr sinusoidal modulation, thereby allowing long averages without significant smearing of the signal. We are continuing to monitor SN 1987A at the 10-kHz sampling rate to search for other periodicities and the possible reappearance of the submillisecond pulses."

1989 February 24 **(4743)** **Daniel W. E. Green**

No pulsation found !



ASTRONOMY

"Spinning pulsar" claims retracted

New Orleans

ASTRONOMERS who last year reported a pulsar that was apparently rotating at an unheard of rate of nearly 2,000 times a second have discovered an experimental error in their data that could negate the results. Speaking at the annual meeting of the American Association for the Advancement of Science this week, John Middleditch, an astronomer at the Los Alamos National Laboratory, said that interference from a video camera may have caused the spurious data. The pulsar's perceived rotational frequency of 1968.63 Hz corresponds to a characteristic video frequency.

Signals indicating the apparent pulsar had been spotted only once in the debris left after supernova 1987A (see *Nature* 338, 234–236; 1989), but subsequent statistical analysis of the data seemed to confirm the event. Such a quickly spinning pulsar would defy conventional theory and has sparked a number of new proposals in the hope of explaining it.

G. Christopher Anderson

No pulsar in SN1987A

SIR—Our previously reported observation (*Nature* **338**, 234–236; 1989) of what appeared to be an optical pulsar in the remnant from supervova 1987A turns out to be spurious. Despite repeated searches by us and others following the original observation in January 1989, the putative pulsar was not confirmed. In new data obtained in February 1990, however, we again detected the signal, in data from the supernova and, in comparison data taken on the Crab pulsar at the same time. From this, it is clear that the signal did not originate in the supernova, and we retract our reported discovery of the pulsar.

We believe that the observed signal is electrical noise from a closed-circuit television camera used for acquisition and guiding at the Cassegrain focus of the 4-metre telescope at Cerro Tololo Interamerican Observatory, where both sets of data were taken. The observed frequency of 1968.627 Hz is close to the 16th subharmonic of the nominal horizontal sync pulse of the camera (1968.75 Hz); the coincidence seems too close to be accidental.

We do not know how the signal coupled into our detector, and have not been able fully to reconstruct events during the observations. But we think there are plausible explanations for some of these things that made the original observation appear real. The most important are: (1) The signal disappeared when the telescope was pointed at a different object immediately after observing the supernova. It is likely that the offending guider camera was turned off between the two sets of observations to prevent damage from the increasing light of twilight.

(2) The signal was not observed with the same equipment on the same telescope, either before or after the detection run, until the run in February 1990. Several plausible explanations for this come to mind, any one or more of which might have occurred: there may have been subtle differences in the mounting of the detector system, changes in the adjustment of components, or a different guider camera (there are two such cameras at the telescope, which are used interchangeably). The system is extremely sensitive, and the detected signal was very small by normal standards: the interference current was equivalent to about 10^{-15} amps.

(3) Several highly suggestive properties of the observed frequency were totally fortuitous. The stability of the frequency over the 7-hour run was high (10^{-6}), a factor of 100 better than the stability specification for the camera. Furthermore, the observed small frequency change was quite smooth, and when the data were corrected for the Earth's motion, they were well fit by a sine wave, which suggested an external origin. (When a sine wave was subtracted from the data, the frequency residuals decreased by an order of magnitude. This was the basis for speculation that, for example, the pulsar might be in a binary orbit.) Similarly, the fact that the first two higher harmonics were in the same proportions as those seen in the Crab pulsar was a coincidence. All this was undoubtedly a combination of bad luck (or divine malice), misplaced pattern-finding skills, and the common human tendency to overinterpret a limited amount of data.

Searches for the pulsar continue, so far unsuccessfully.

J. KRISTIAN*

The Observatories,
Carnegie Institution of Washington,
813 Santa Barbara Street,
Pasadena,
California 91101, USA

*Co-authors of this letter are C. R. Pennypacker, J. Middleditch, M. A. Hamuy, S. Heathcote, J. N. Imamura, W. E. Kunkel, R. Lucino, D. E. Morris, R. A. Muller, S. Perlmutter, S. J. Rawlings, T. P. Sasseen, I. K. Shelton, T. Y. Steiman-Cameron and I. R. Tuohy.

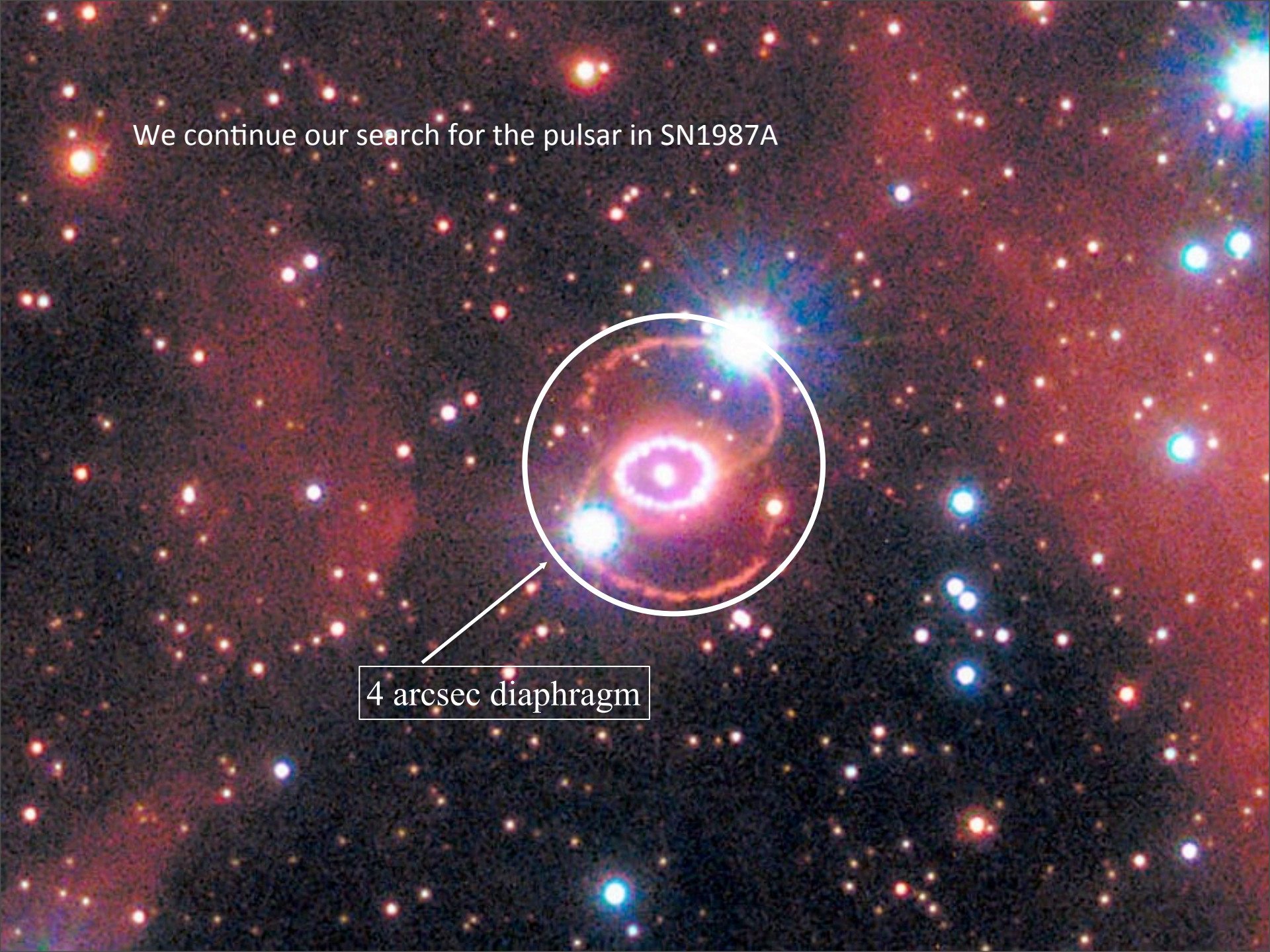
in the Crab pulsar was a coincidence. All this was undoubtedly a combination of bad luck (or divine malice), misplaced pattern-finding skills, and the common human tendency to overinterpret a limited amount of data.

Searches for the pulsar continue, so far unsuccessfully.

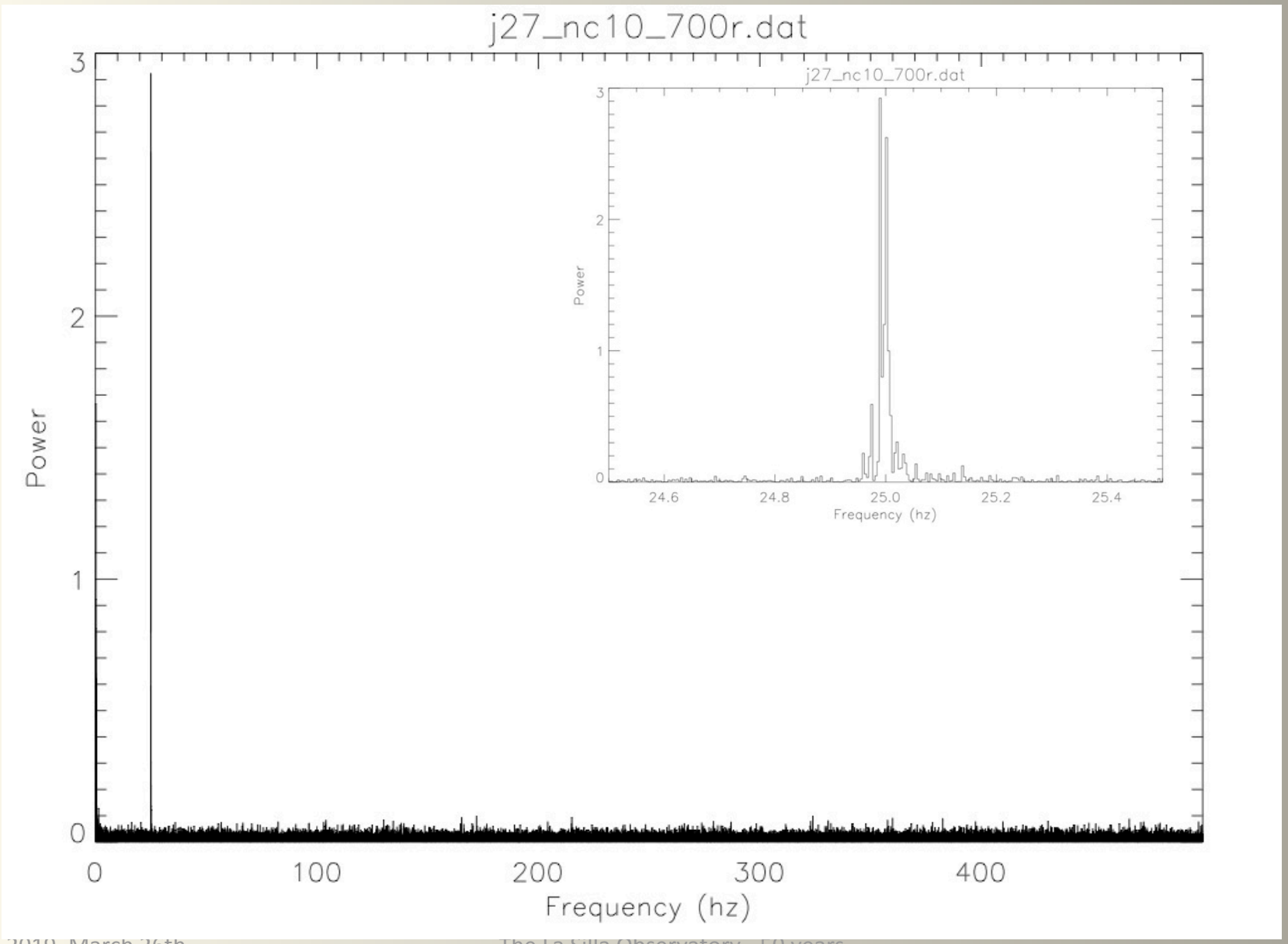
J. KRISTIAN*

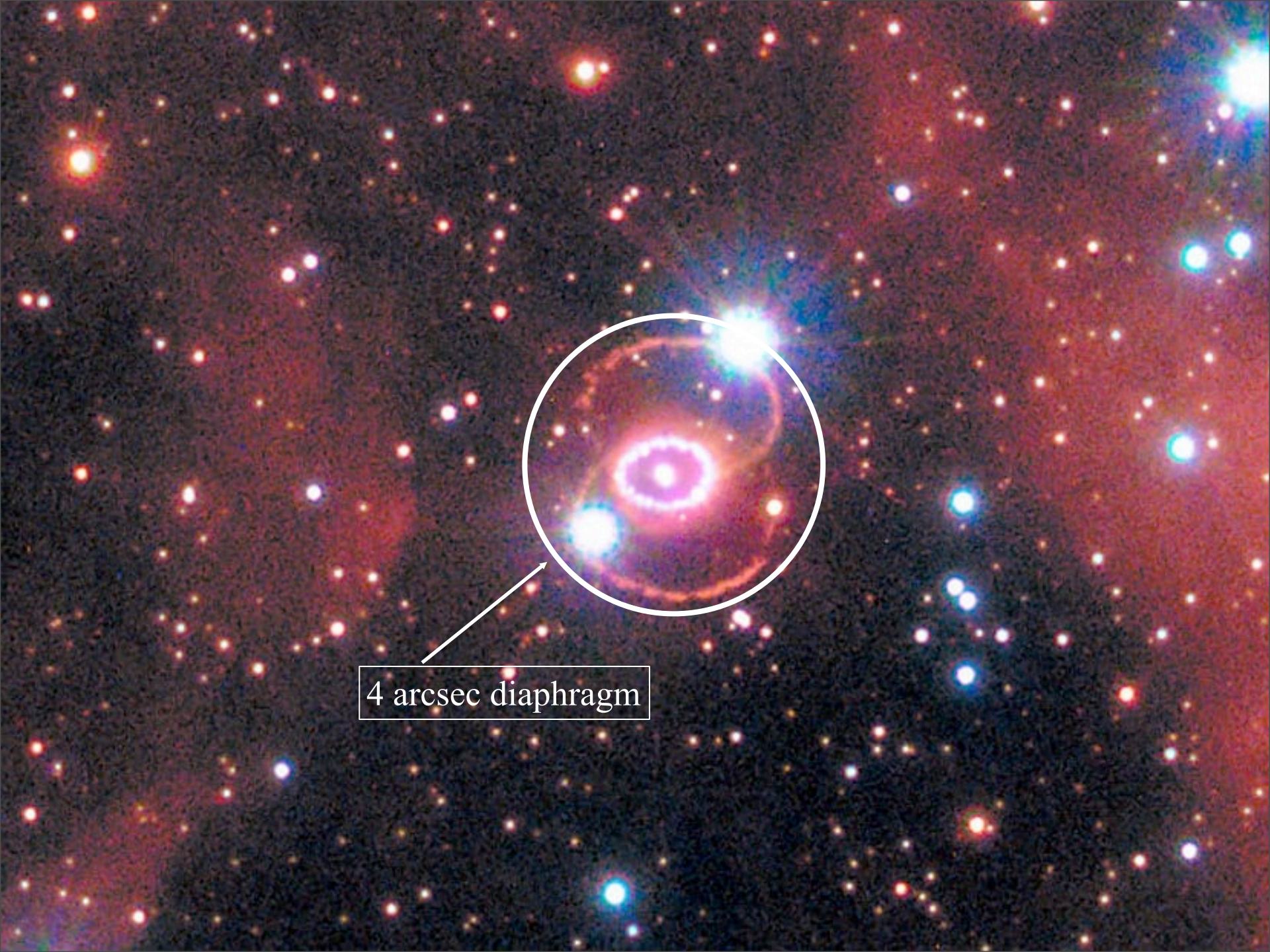
Nature, 22 February 1990

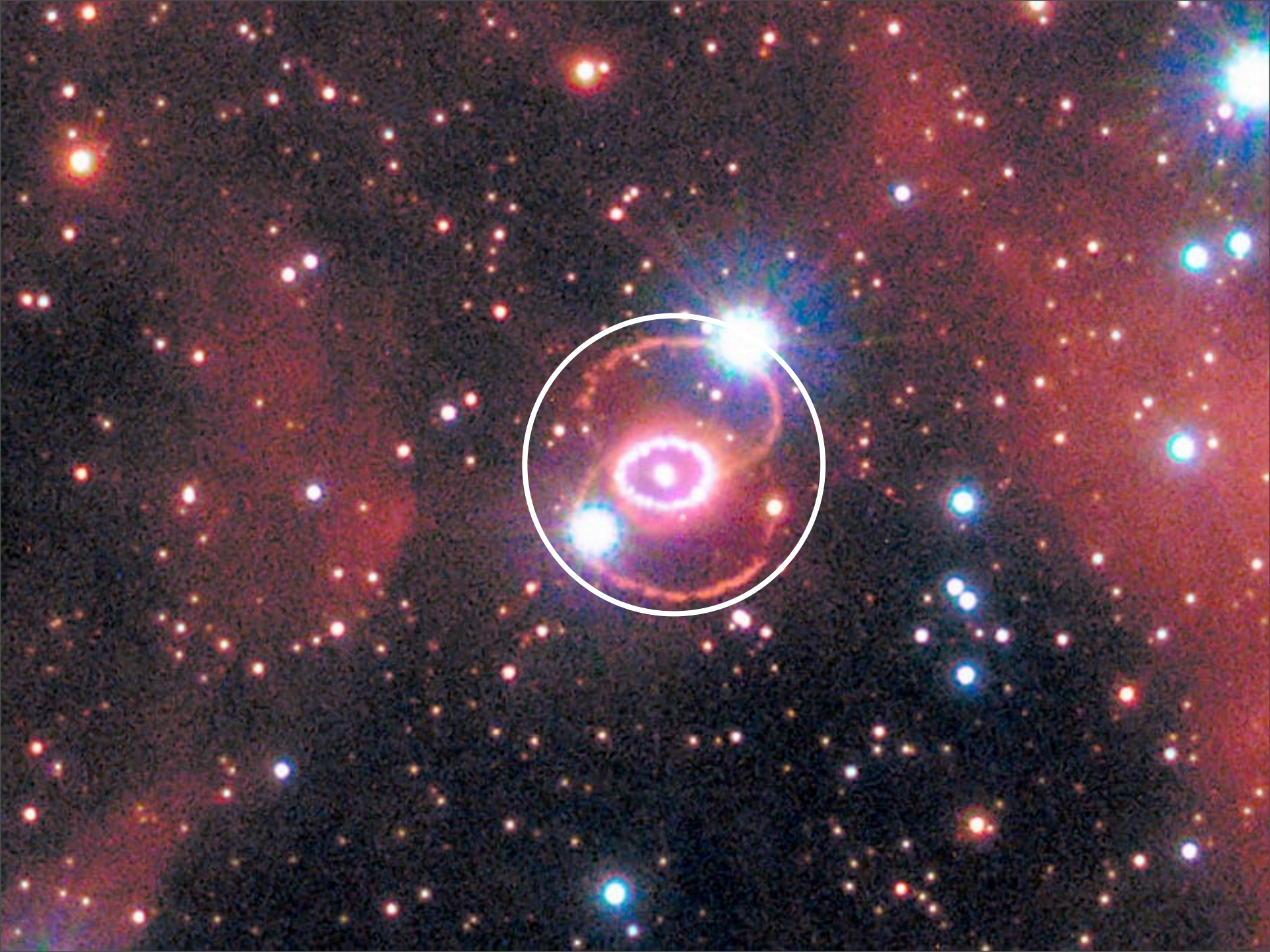
Nature, 28 February 1991


We continue our search for the pulsar in SN1987A
4 arcsec diaphragm

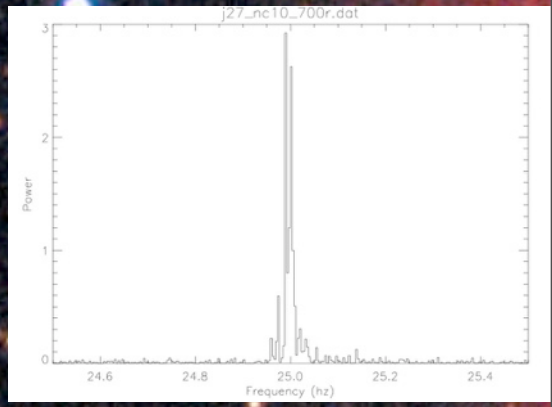
As written by J. Kristian : Indeed, over-interpretation tempting




4 arcsec diaphragm



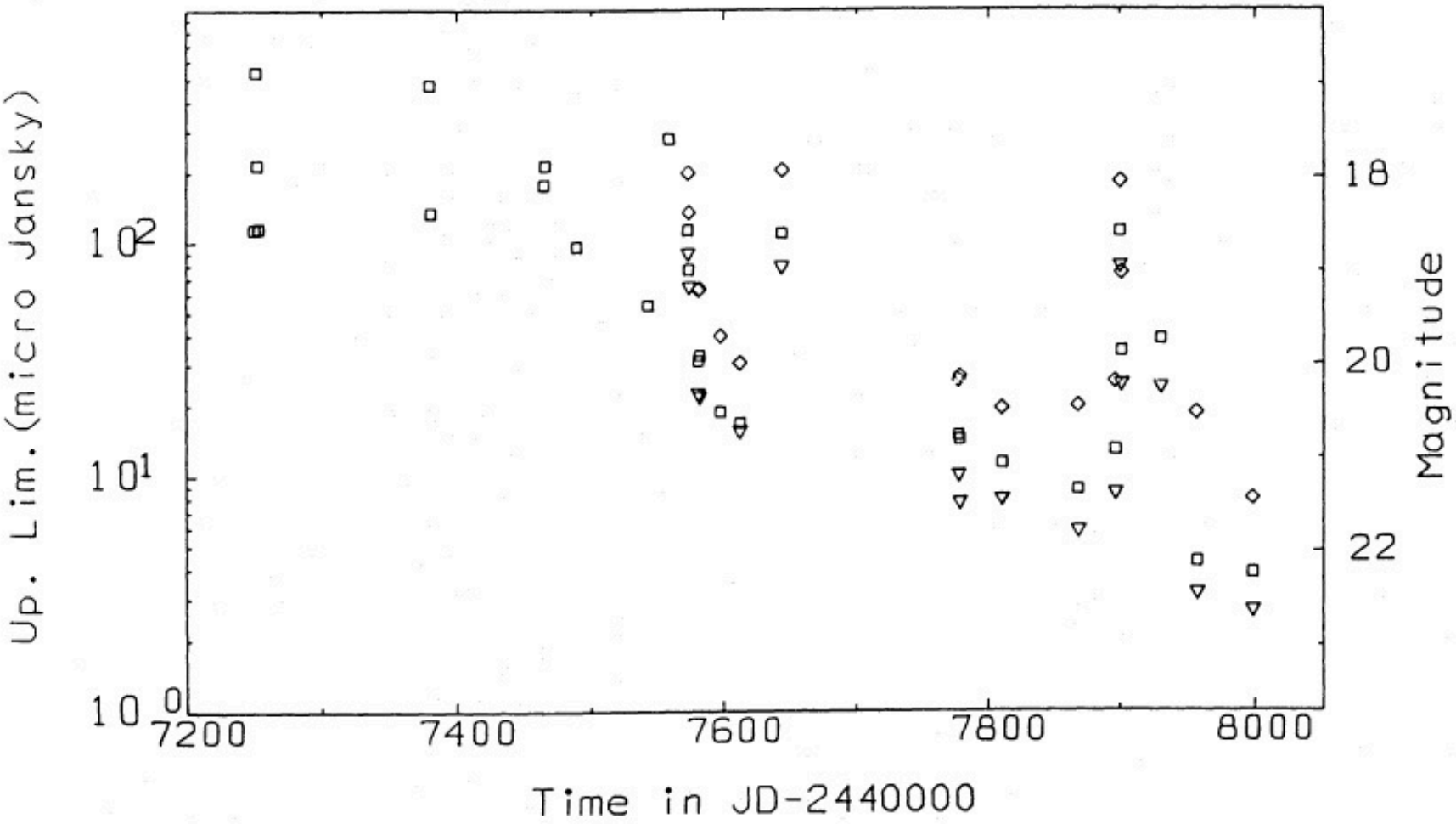

ewt


j27_nc10_700r.dat
Power
3
2
1
0
24.6
24.8
25.0
25.2
25.4
Frequency (hz)

Search for the optical signatures of a pulsar in SN 1987 A

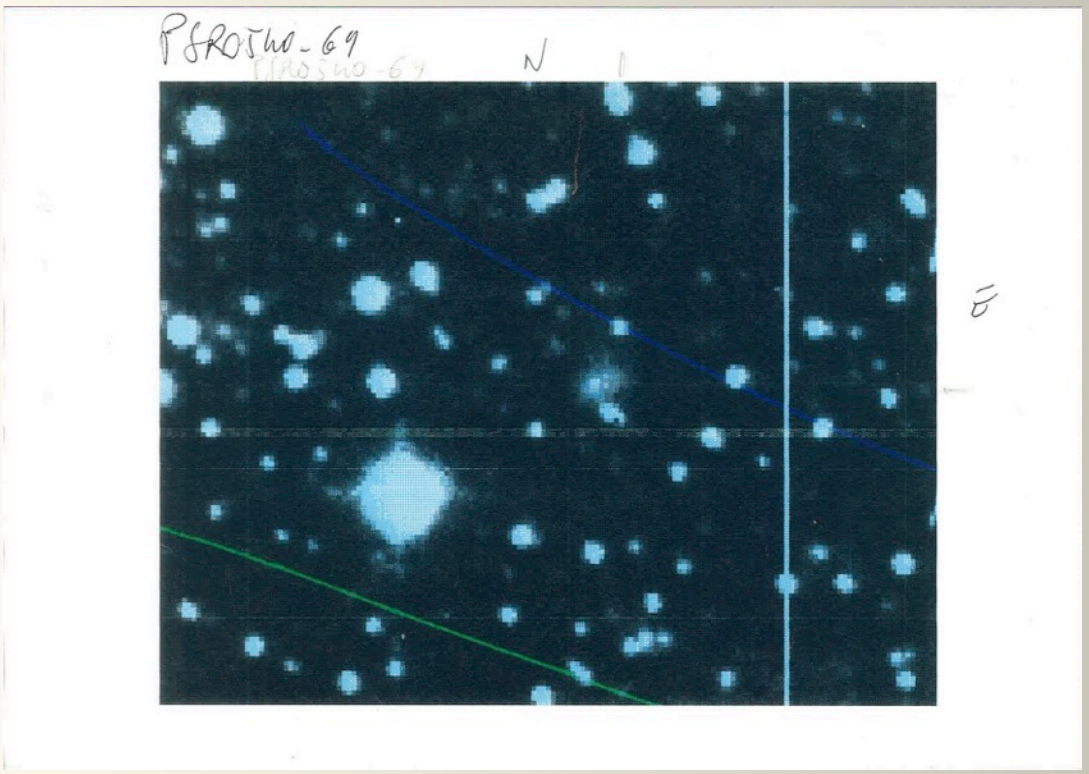
H. Ögelman[1], C. Gouiffes[2], T. Augusteijn[2], H. Pedersen[3], F. Gutierrez[2], G. Hasinger[1], J. Melnick[2], W. Pietsch[1], and C. Santini[2]

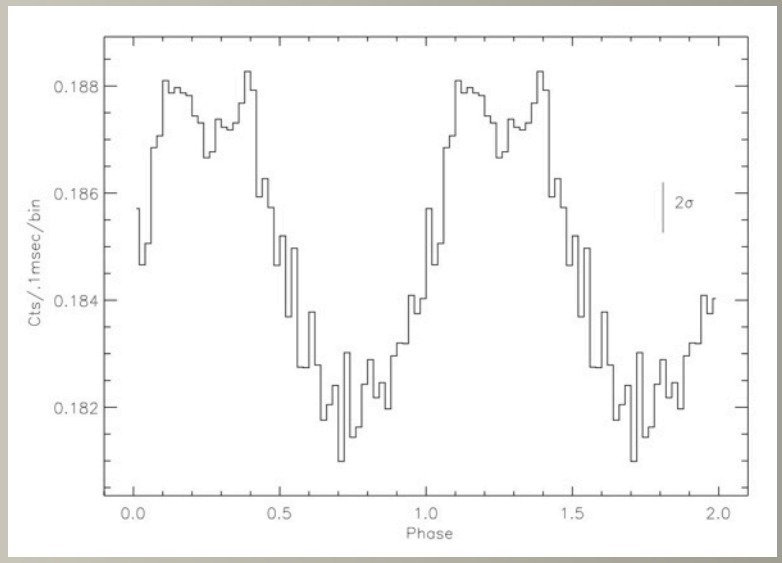
[1] Max-Planck-Institut für Extraterrestrische Physik, Karl-Schwarzschild-Str. 1, D-8046 Garching, Federal Republic of Germany
[2] European Southern Observatory, Karl-Schwarzschild-Str. 2, D-8046 Garching, Federal Republic of Germany
[3] University Observatory, Øster Voldgade 3, DK-1350 Copenhagen, Denmark



Studies of pulsars in the Optical

PSR 0540-60, a 50 msec pulsar in the LMC – the Crab twin -





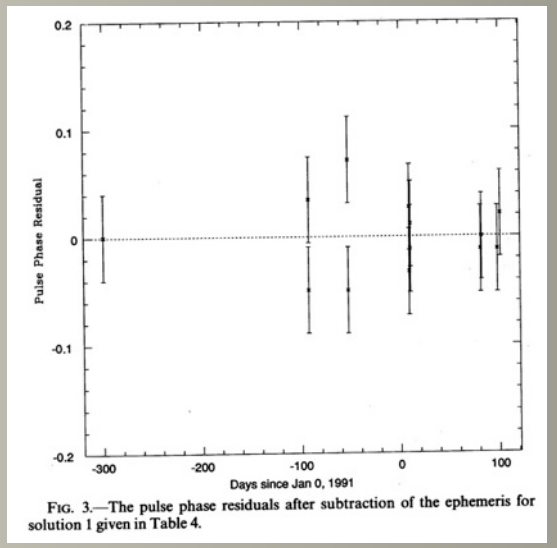


FIG. 3.—The pulse phase residuals after subtraction of the ephemeris for solution 1 given in Table 4.

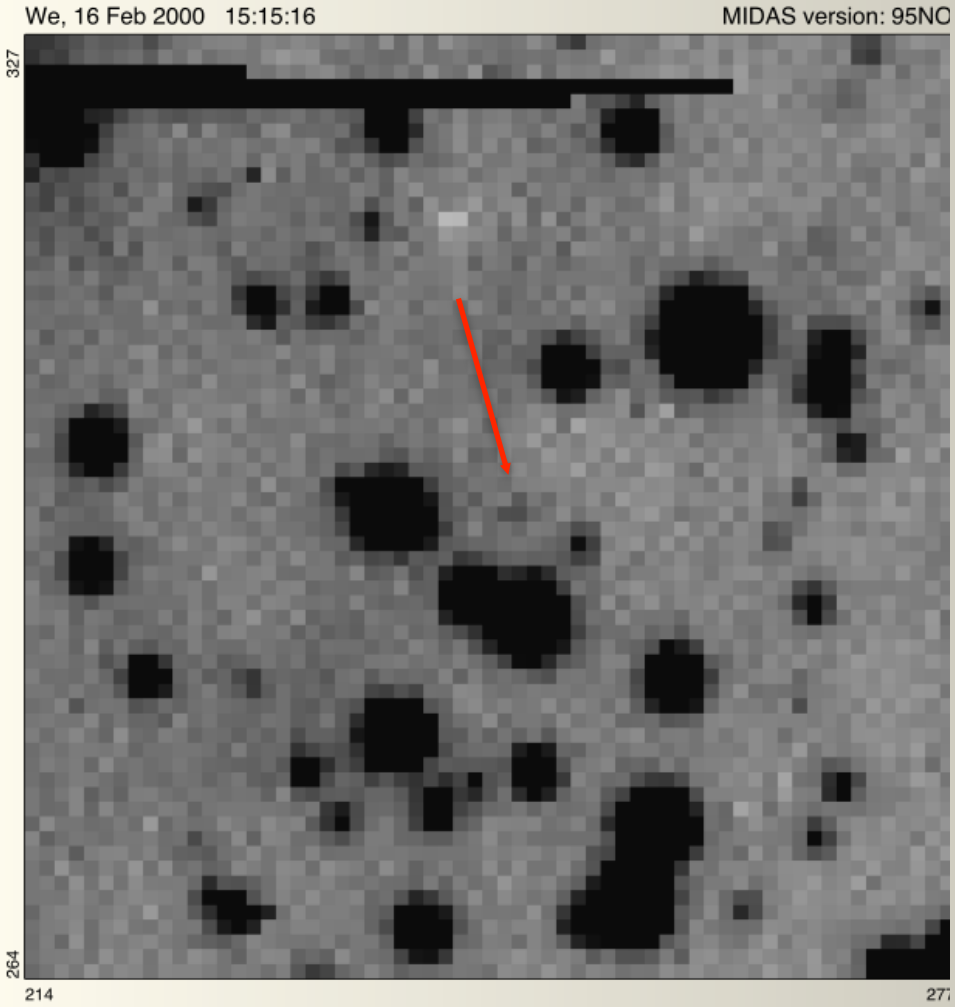
Braking index

$$\dot{\nu} = -k\nu^n$$

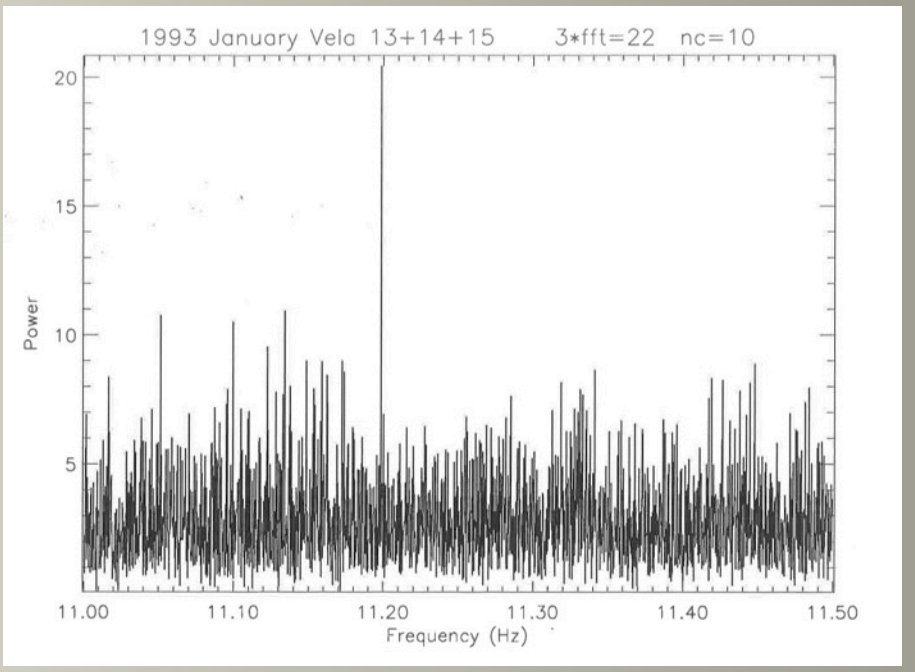
n = 2.04±0.02

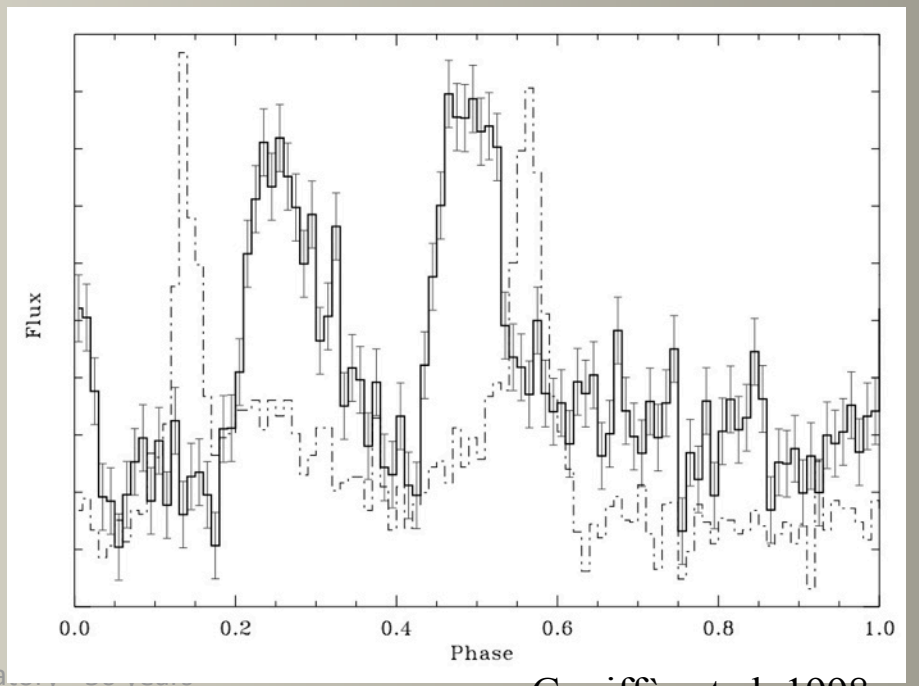
Gouiffès et al, 1992

PSR0833-45, the Vela pulsar



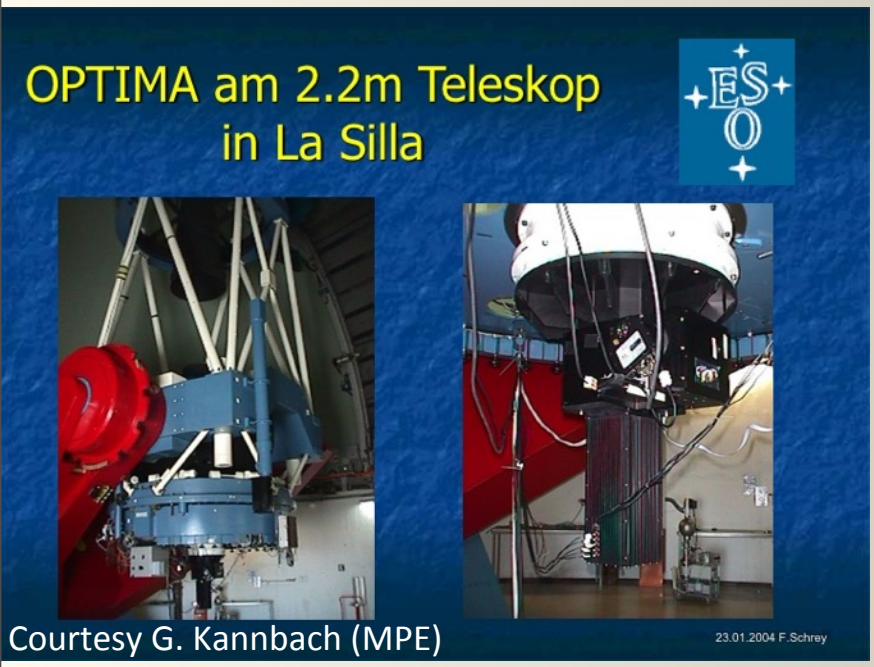
Frame : vela_r2_rot
Identifi : VELA/R/10MN
ITT-table : ramp.itt
Coordinates : 214, 264 : 277, 327
Pixels : 1, 1 : 512, 512
Cut values : 10000, 12300
User : gouiffe

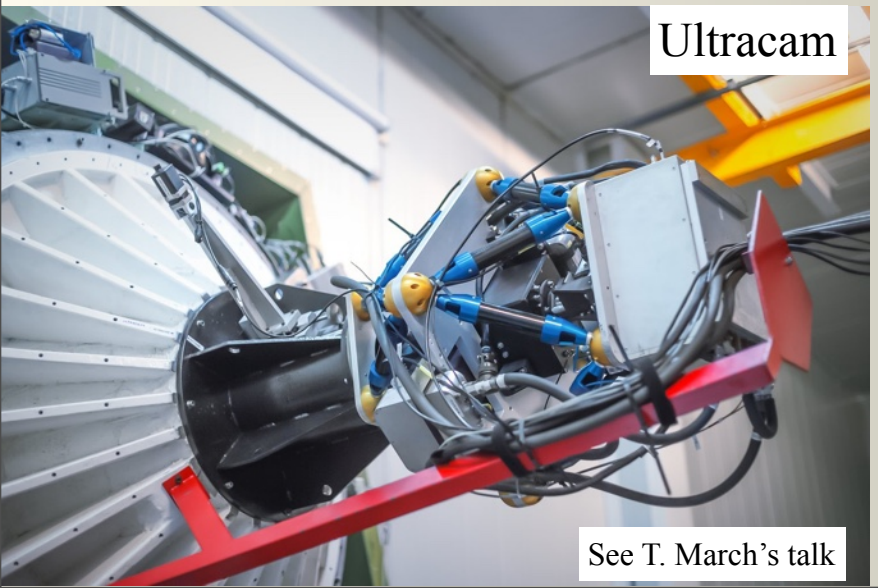




Gouiffès et al, 1998

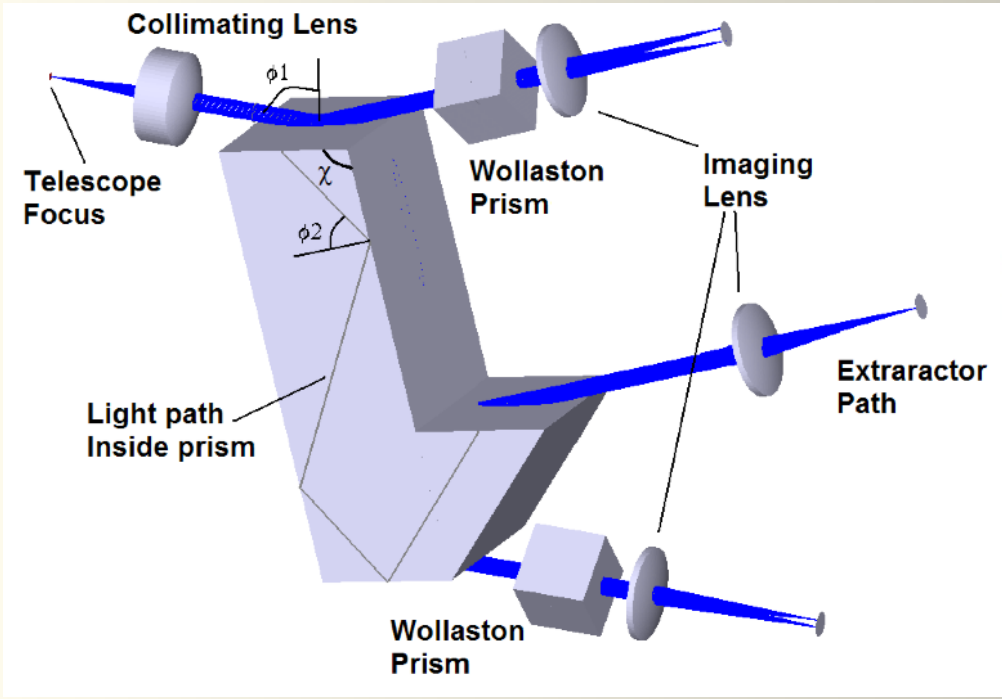
The ESO 3.6m photometer was decommissioned in the 90's
New instruments since , 2D devices, etc

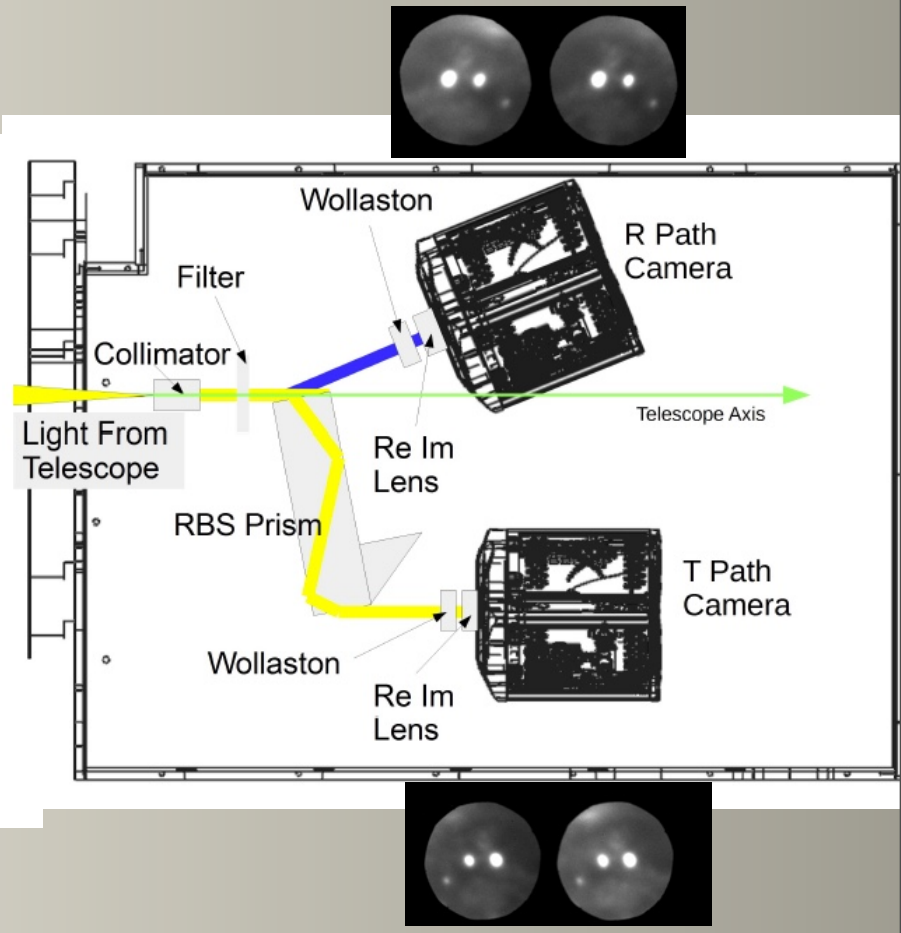




GASP : Galway Astronomical Stokes Polarimeter
(PI Andy Shearer – NUI Galway)
High-speed Imaging polarimeter

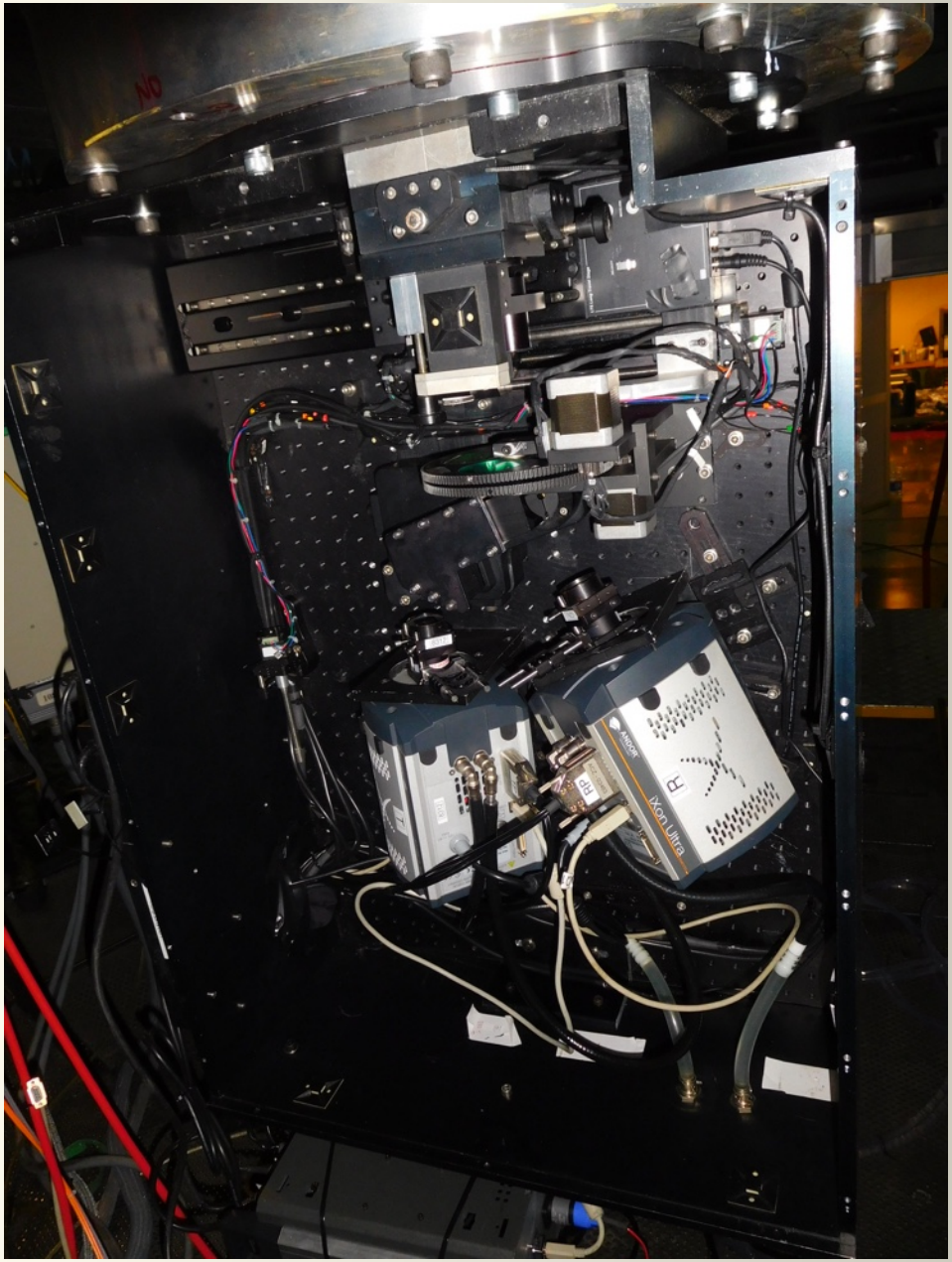
Visitor instrument on WHT, Palomar 200'', OHP 193cm and **ESO3.6m**

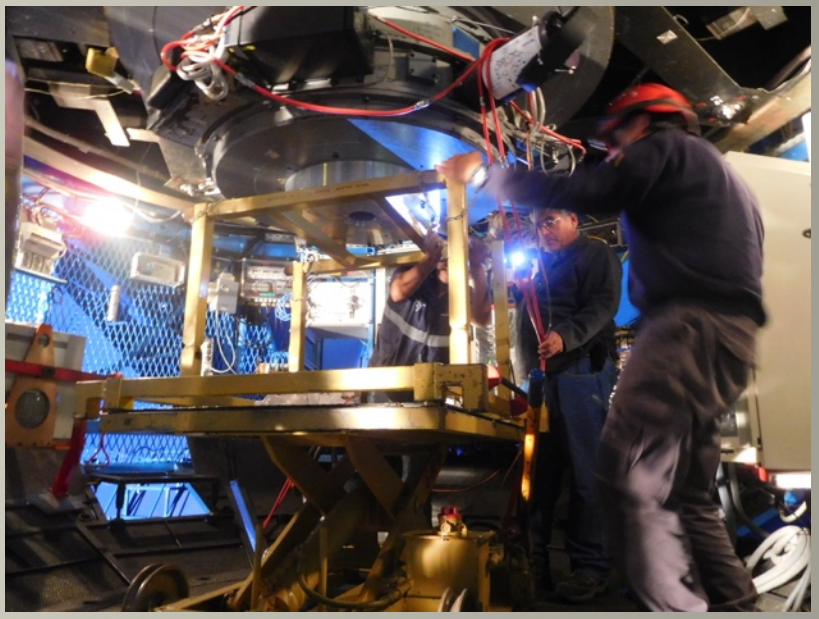


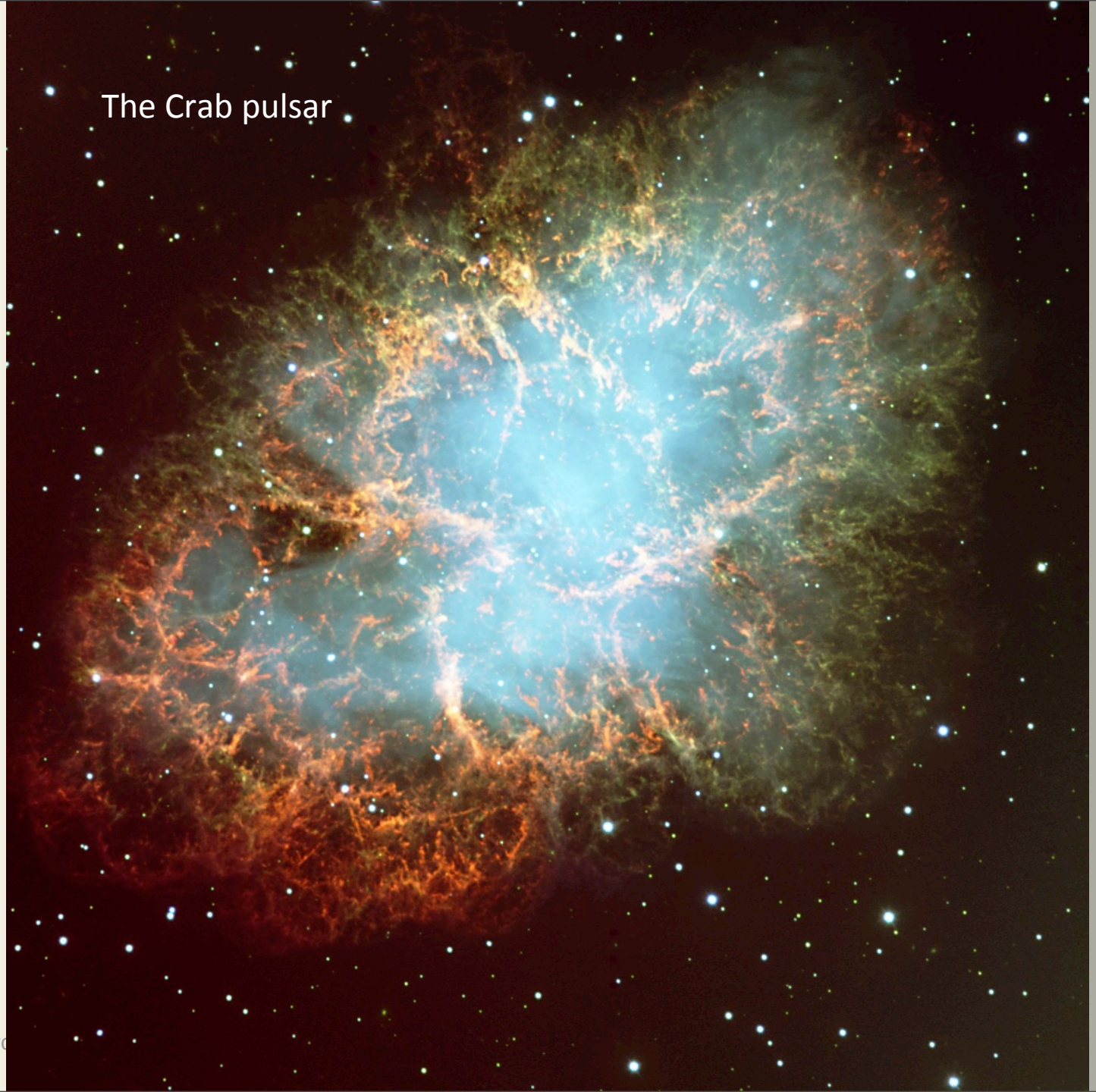


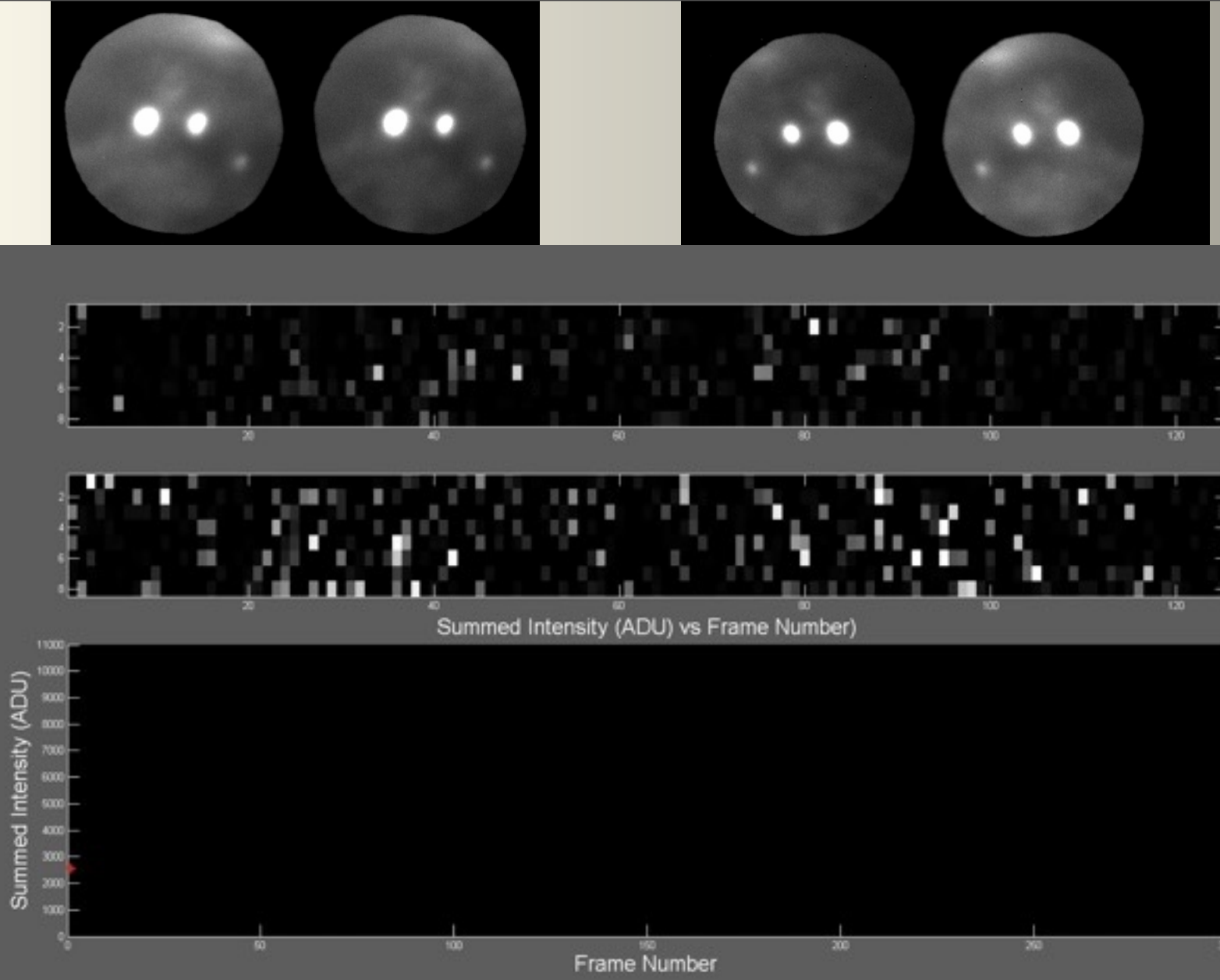
GASP mounted at the cassegrain focus of 3.6m in summer 2018 and 2019 :
3.6m offered for a visiting instrument

This picture is extracted from a movie


Andor
iXon Ultra

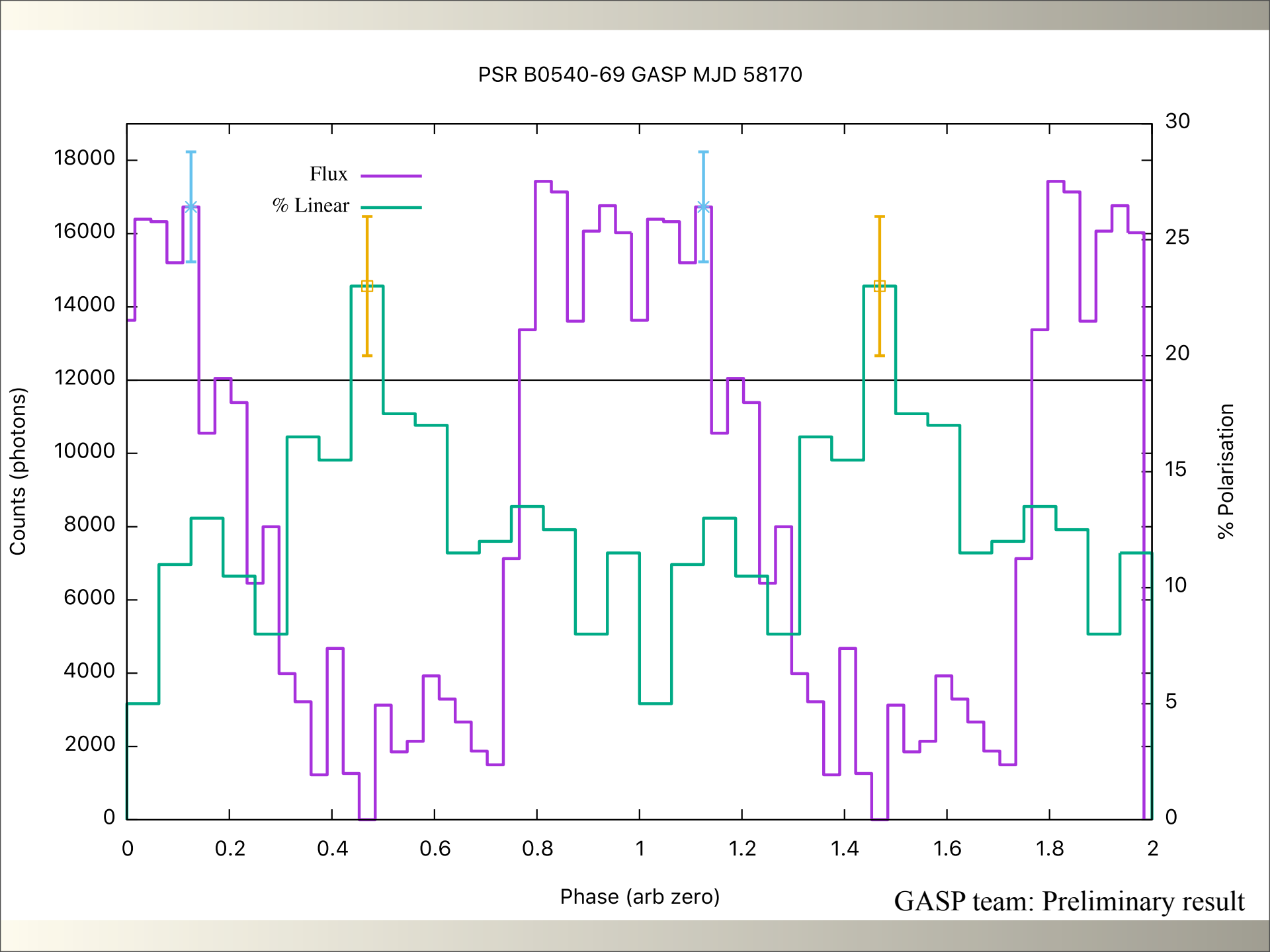



The Crab pulsar



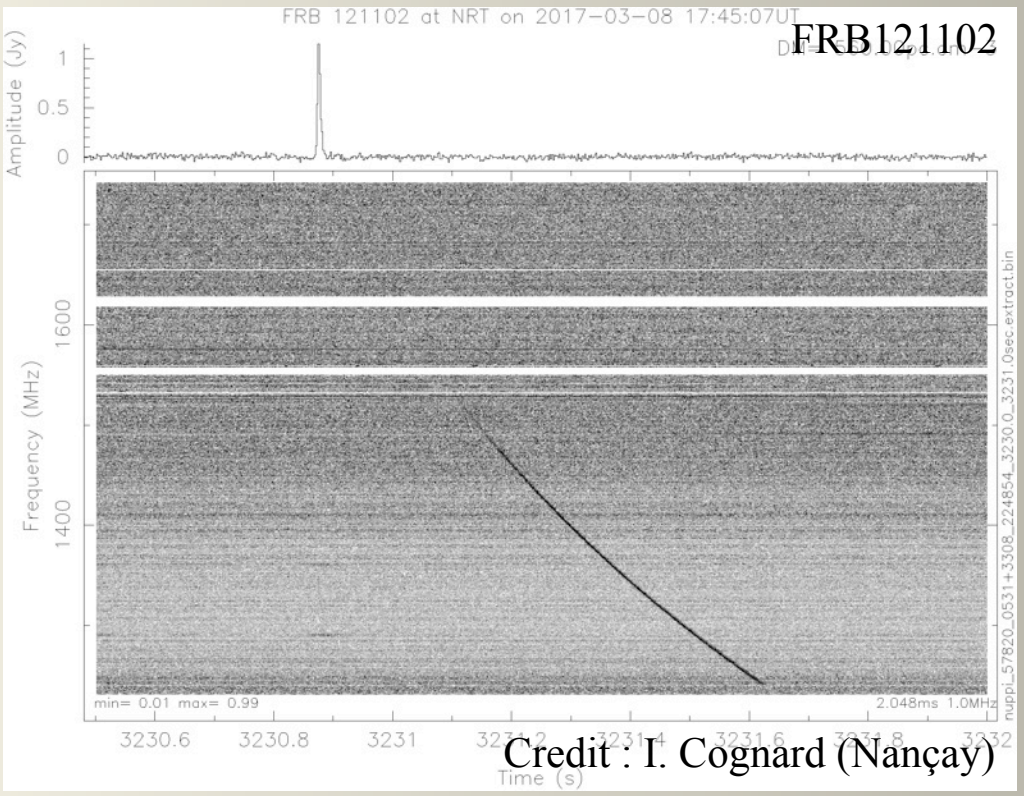
The Crab pulsar seen with GASP

This picture is extracted from a movie
Credit: E. O'Connor, A. Shearer


PSR B0540-69 GASP MJD 58170
Flux
% Linear
Counts (photons)
% Polarisation
Phase (arb zero)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
0
5
10
15
20
25
30
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
GASP team: Preliminary result

High Time Resolution Astrophysics, a window with many potential discoveries

Ex : The Fast Radio Bursts : radio burst at msec timescale.



Need good instrumentaion + telescope acces (preferably with a large collecting surface)

Conclusion - II

Need for a visiting instrument program at ESO

- at La Silla and/or Paranal

- To be adressed during the round table on Friday ?


Muchas gracias por su atención