Why is the Identification of the Pulsar so Important?

Being only the third radio pulsar for which the optical image has been found, PSR 0540-693 now belongs to a most selected and interesting group of objects. It is now possible to concentrate future observations to the corresponding optical object and to better exclude the disturbing background light from the surrounding nebula. There is no doubt that it will be very thoroughly studied by large optical telescopes during the coming years and the groups have already applied for additional observing time at ESO as well as with the Hubble Space Telescope.

When the direction to the pulsar is known with the highest achievable precision, it is possible to take correctly into account all the various effects introduced by the Earth's uneven motion and thereby to combine observations of individual pulses accurately over long periods. This will allow to properly measure the progressive lengthening of the pulsar period, the exact value of which is of key importance for understanding the pulsar mechanism. Of the 550 pulsars presently known, this measurement has only been made for the two youngest ones, the pulsar in the Crab Nebula and PSR 1509-58. The age of PSR 0540-693, as deduced from the lengthening of its rotation period, is not yet well determined, but it is likely to be the third youngest known.

In this connection, note also the recent identification by the Italian group of the nearby, but radio-quiet pulsar, Geminga, see *The Messenger* **No.** 70, p. 30.

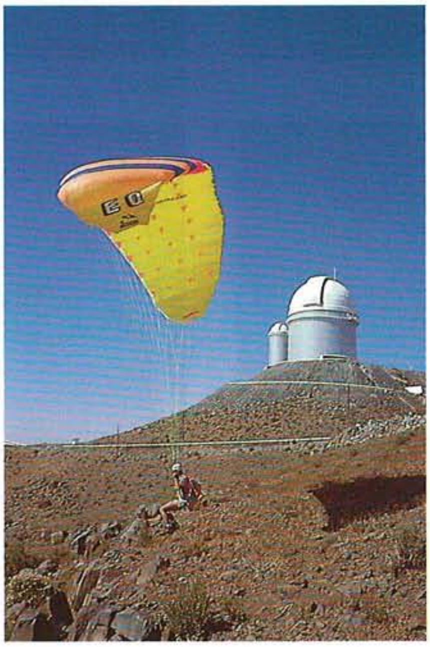
From ESO Press Release 4/93, June 3, 1993.

"El Cóndor Loco" Tests the La Silla Winds!

After many long and exciting nights at La Silla during my time as "French cooperant" in 1992–93, I enjoyed a few times the thrill of testing in a very special way the wind patterns around that mountain.

Everybody knows of course how important it is to study the local atmospheric conditions around observatories in connection with the seeing investigations, etc. Astronomers all around the world are doing so, and when you can combine the "useful" with the pleasent, why not? True, I must admit that I could not avoid a certain feeling that this particular method of aerodynamic investigation may not have been entirely permitted at La Silla, but if you have ever tried to imitate the peaceful and majestic condors of the Andes, then it is very difficult not to attempt it.

This picture was taken by Marc Moniez and is for me an unforgettable souvenir of this good old time. Hoovering around the mountain, I experienced the beautiful site of the ESO observatory as no astronomer has ever before (and probably also after) me.



Beware! I absolutely do not recommend other potential astronomical paraglider pilots to follow me unless they have a very thorough experience indeed. The airflow conditions around La Silla, as it turns out, are not ideal for such flying; this is also common knowledge among the poor photographers who, hanging dangerously in open doors of one-engine planes, have obtained photos of the observatory in impossible angles. I did come back from Chile with some (fortunately minor) holes in my gossamer wings, punctuated by a stray cactus at the time of a rough landing.

If they follow my advice, they should rather go to "Cerro Grande" above the La Serena bay where they will encounter good conditions for dynamic flight in non-turbulent conditions ensured by the wind from the sea. Or for long summer flights, go to "Batuco", some 20 kilometres north of Santiago. You can also easily fly at the various ski resorts above Santiago, and the very best is the "Cerro Providencia" flight, 2,500 metres above the Chilean capital – an experience, I promise, that you will never forget!

A todos los que se acuerdan todavía del "cóndor loco".

B. ALTIERI, ESA/ESTEC, Noordwijk, The Netherlands

TRIFFID Imaging of 47 Tuc on the NTT

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The four images shown here illustrate the observational possibilities with TRIFFID, the TRansputer Instrument For Fast Image Deconvolution which was used to identify the optical image of the pulsar PSR 0540-693 in the LMC, cf. page 27 in this *Messenger* issue.

The processing of these frames is still quite preliminary – various techniques are proving promising and are being incorporated into a single flexible process. The amount of processing is quite horrendous. Image files contain pixel addresses and times for every single photon – a maximally uncompressed

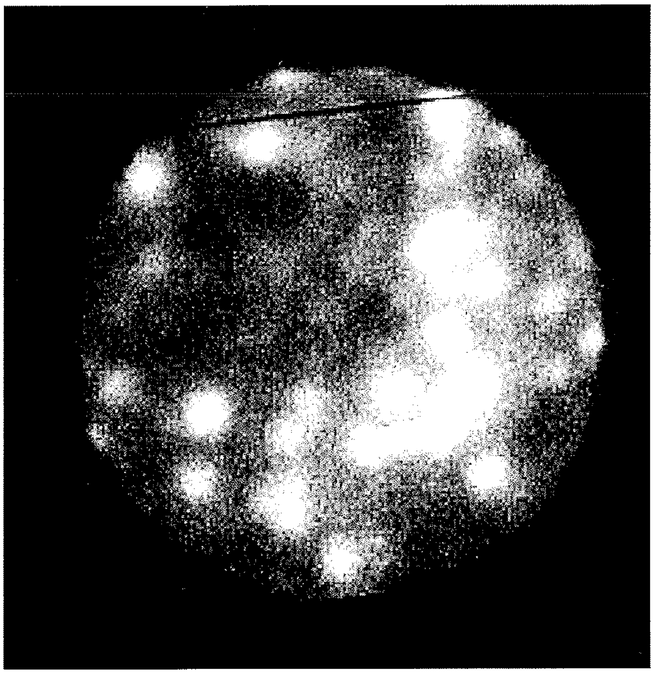

Figure 1.

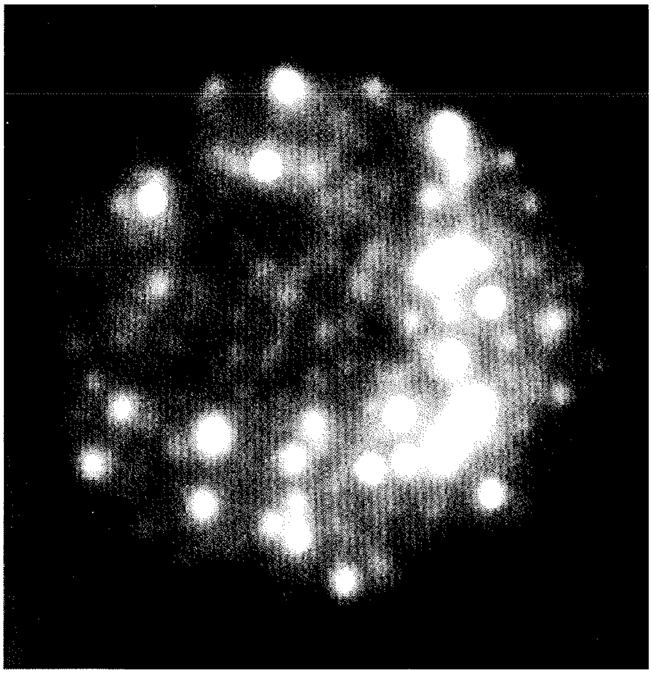

Figure 2.

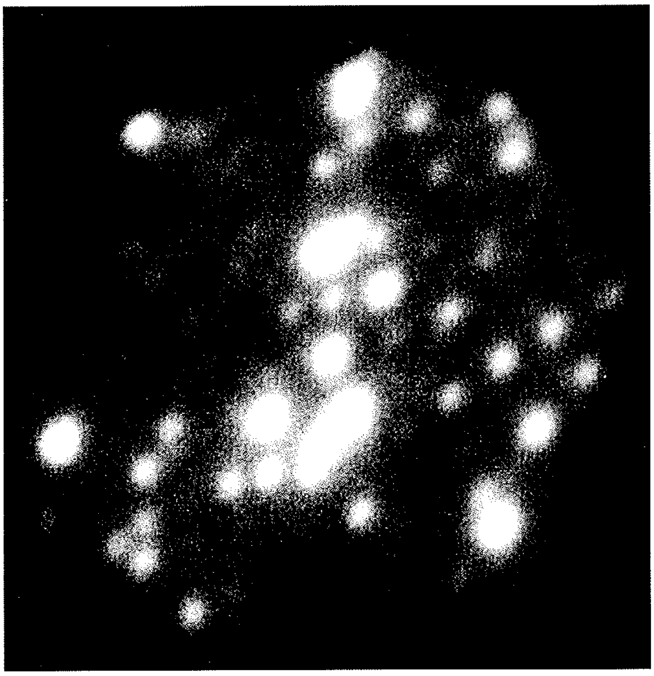

Figure 3.

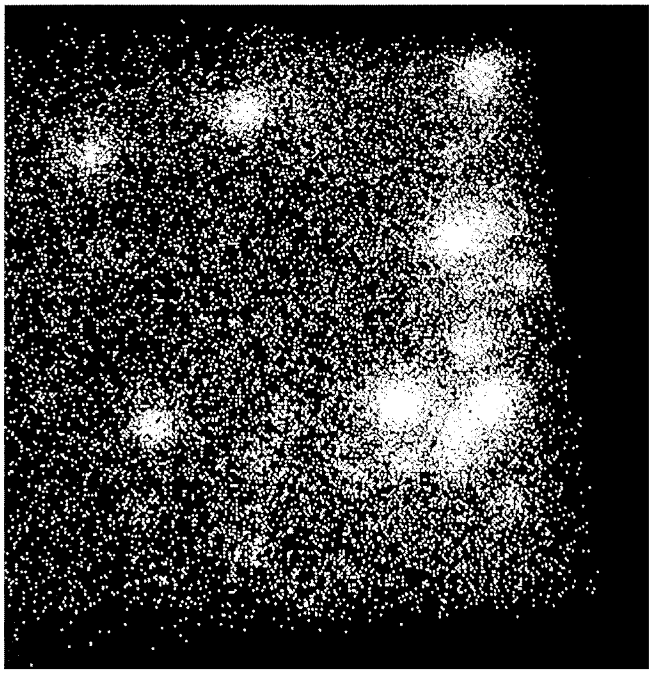

Figure 4.

format. There are altogether about 25 Gbytes of such numbers to process. Fortunately we have recently been able to increase our in-house processing power considerably and we now have 3 HP9000 series workstations (710, 720, 735) boosted by Transputer and TMS320C40 DSP networks.

Here are some details about the individual images:

Figure 1: MAMA images of the optical centre of 47 Tuc taken with TRIFFID on the NTT August 22, 1992. The optical scale was 0."087 per pixel. There were no filters so the predominant response was blue (from the photocathode response). The seeing was actually rather poor after a very stormy period. The raw image has a half width of >1."0. The zenith distance was > 50° – the raw image is 5 minutes integrated and de-rotated only. At this time it was not possible (for software reasons) to use the NTT de-rotator platform so software de-rotation was necessary – this has now been fixed. The magnitude of the brightest star in the field is ~15. The data are from one sub-pupil only of 0.57 m diameter, which is matched to the (rather poor) seeing. Note the missing row of pixels, which is due to one of the anode strips becoming internally disconnected.

Figure 2: 30 minutes of the same dataset integrated, de-rotated and sharpened by shift-and-add only (no frame selection). The image width has improved to 0."6, which is close to the theoretical limit of improvement of a factor 2. Note that the missing row of pixels has vanished. This is due to the fact that in the missing row the photons are piled up in the adjacent row – the process of shifting smooths out the pile-up. Image motion was determined from the weighted centroid position of a "composite star" formed by the co-addition of the brightest 10 stars in the field and integrated with a variable time-weighting determined by the seeing rather than using a slab integration. The time

weighting is performed by creating a (Weiner) temporal filter matched to the correlation properties of the atmosphere on a particular occasion. In this way one can achieve the highest possible number of reference photons (avoiding purely statistical fluctuation in centroid position) without integrating into the image genuine atmospheric movement. In the case of a bright reference the effective integration time can be reduced. The star profiles of the sharpened image have rather sharp cores indicating that a further stage of improvement can be expected from image selection – we would also expect that there will be a further improvement when the centroid is determined by reference to the brightest region in the composite reference, a method which we have previously demonstrated with MAMA data (of M15, using the 4.2-m WHT). In a number of cases groups have stars that have become resolved in the sharpened image compared to the raw image – which would have been considered to be of good resolution until recently.

Figure 3: TRIFFID has the ability to perform image sharpening in two colours simultaneously. The MAMA is used on a straight-through optical path to perform blue imaging and to give information about image motion and width. The same information is applied to the side-arm detector, which is in this case the RAL-PCD, imaging in the red. The RAL-PCD is an image intensifier plus CCD real-time centroiding photon-counting camera. A narrow strip of the photocathode (50 by 500 pixels) is read out every 7 milliseconds, which produces 200 by 2,000 pixels after centroiding in an array of Transputers. The image scale is 1.7 times larger than the MAMA. The image is the result of derotation and sharpening using the MAMA centroid – the resultant resolution is 0.″7, comparable with that of the MAMA. The field looks quite different from the blue image.

Figure 4: The side-arm image sharpening does not have the same requirement for large numbers of reference photons which plagues most high-resolution imaging techniques – since the sharpening information is transferred from the straight-through arm. In fact, the Hα image displays the best final resolution at 0.″5 – the maximum gain allowed in theory. One purpose of narrow band imaging in the crowded centre fields of globular clusters, for example, is to look for activity which might be indicative of the presence of a cataclysmic variable star.

These images were achieved in conditions of only moderate seeing. In better seeing we have demonstrated that the process improves faster than the relative improvement in seeing. In better seeing the pupil sizes can be increased (this sort of image sharpening optimally uses pupils which are 3.5–4 times the diameter of the diffraction-limited telescope which would reproduce the seeing-limited image width), thereby increasing count rates, thereby changing the optimization between Weiner filter width and atmospheric correlation time.

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Wolf-Rayet Stars Beyond 1 Mpc: Why We Want to Find Them and How to Do It

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1. Why

Wolf-Rayet stars are luminous objects with broad and conspicuous emission lines. In principle they can be observed out to large distances. Over many years of intensive search and with contributions from many workers, a practically complete catalogue of the WR population in the Magellanic Clouds has been obtained. In other local group galaxies similar searches were conducted and individual WR stars have been identified in most of them.

Here we report about our efforts to extend this search beyond the local group into the Sculptor group of galaxies. We selected NGC 300 as a suitable member of this group because its inclination to the line of sight is relatively small. Its distance modulus of 26 mag corresponds to 1.5 Mpc thus giving a scale of 7 pc per arcsec and allowing under good seeing conditions to resolve areas of about 6 pc. In spite of the low spatial resolution we expect that most of the WR stars can be observed individually, i.e. uncontaminated by other WR stars. If we take the spatial distribution of WR stars in the LMC as a guideline, we see that about half of them are located in large OB associations (15 pc to 150 pc) (Breysacher, 1988) and almost all of the others are widely scattered in the galaxy (Pitault, 1983). Only a few per cent are found in dense structures like the tight clusters ($\leq$ 5 pc) in the 30 Doradus area (Moffat 1987, Schild and Testor 1992). Such 30 Dor-like concentrations of massive stars are extremely bright and can be observed to distances even far beyond the Sculptor group. Broad WR emission features have indeed been found in many giant H II regions and H II galaxies (see eg. Arnault et al. and references therein). From these objects we can however only obtain synthetic information about the population of the massive stars as a whole. If possible, it is preferable to trace WR stars individually and consequently to study them in various environments because:

- The frequency and subtype distribution of WR stars in a galaxy provides fundamental clues in relation to stellar evolution theory. Metallicity effects are currently thought to dominate most aspects of a WR population (see e.g. Azzopardi et al. 1988, Arnault et al. 1989). The size of the convective core of a massive star together with mass loss processes which remove the outer hydrogen rich layers determine the predicted number of WR stars and the WN/WC ratio at various metallicities (Maeder 1991).
- Deep spectroscopic observations of WR stars in M 33 have established the existence of unusually narrow-lined early WC stars, a type of WR star which was not previously known to exist. The relation between subtype and line width found for galactic WC stars does not hold for these stars. The breakdown of this relationship is unlikely to be a pure metallicity effect and remains unexplained.
- WR stars are highly evolved objects