MERLINnews
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EUROPEAN vlbi NETWORK

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1. Call for Proposals

The **deadline** for the receipt of proposals for Semester 08A (February - June 2008) on MERLIN is **October 31st, 2007**. Details in: http://www.merlin.ac.uk/propsub/call Wavebands available:

L-Band: 1.33GHz to 1.43 GHz & 1.57 GHz to 1.73 GHz

C-Band 4.5 GHz to 5.2 GHz & 6.0 GHz to 6.8 GHz

K-Band 22.0 GHz to 24.0 GHz

- The Lovell Telescope will be available for short periods only during Semester 08A*
- It is envisaged that frequency flexibility between complete observing runs will be available

Proposals should be submitted via the new MERLIN web-based proposal tool

Available at: http://www.merlin.ac.uk/propsub/northstar.html

The system parameters for observation of a continuum source in **good weather conditions** are;

	L-Band	C-Band	K-Band
Maximum angular resolution (mas)	~ 150	~ 40	~ 8
RMS for 12 hr. on source (µJy/beam)	~ 60/30	~ 60/30	~ 400
Maximum bandwidth/polarization (MHz)	~ 15	~ 15	~ 15

*The use of the Lovell telescope at L-Band and C-Band reduces the 12 hour RMS noise level from ~60 to ~30 µJy/beam. The maximum rate at which the observing frequency can be switched within an observing band will be approximately once every five minutes for multi-frequency synthesis (MFS) observations. MFS is possible within each C-Band range (eg 4.5 GHz-5.2 GHz), but not possible between 4.5/5.2 GHz and 6/7 GHz. For spectral line work throughout the Semester, users are referred to Table 4.4 of the MERLIN User Guide Version 3 which is now available online. The maximum number of frequency channels per baseline to be divided between the 4 polarizations for bandwidths of 16 MHz, 8 MHz and 4 MHz are 64, 128 and 256, respectively. The number of frequency channels per baseline to be divided between the 4 polarizations will be 512 for bandwidths of 2 MHz or less. The minimum total bandwidth is 250 kHz.

Access to MERLIN for Scientists from EU Countries: MERLIN is one of the participating institutes in the RadioNet (http://www.radionet-eu.org) project from which transnational access within the EU to existing observing facilities is financially supported.

There will be MERLIN+EVN observations in February / March and May / June 2008. Applications to go to the EVN PC (http://www.evlbi.org/)

2. Director's Report

The move of JBO research staff and some of the *e*-MERLIN/VLBI National Facility support staff to the Jodrell Bank Centre for Astrophysics in the new Alan Turing Building in Manchester took place as scheduled in September. Facilities at Jodrell Bank Observatory are now being rearranged to bring most of the technical, operational and development staff into the main building. Commissioning work on the receivers, IF/LO, samplers, data and clock transmission equipment and software for *e*-MERLIN continues at JBO.

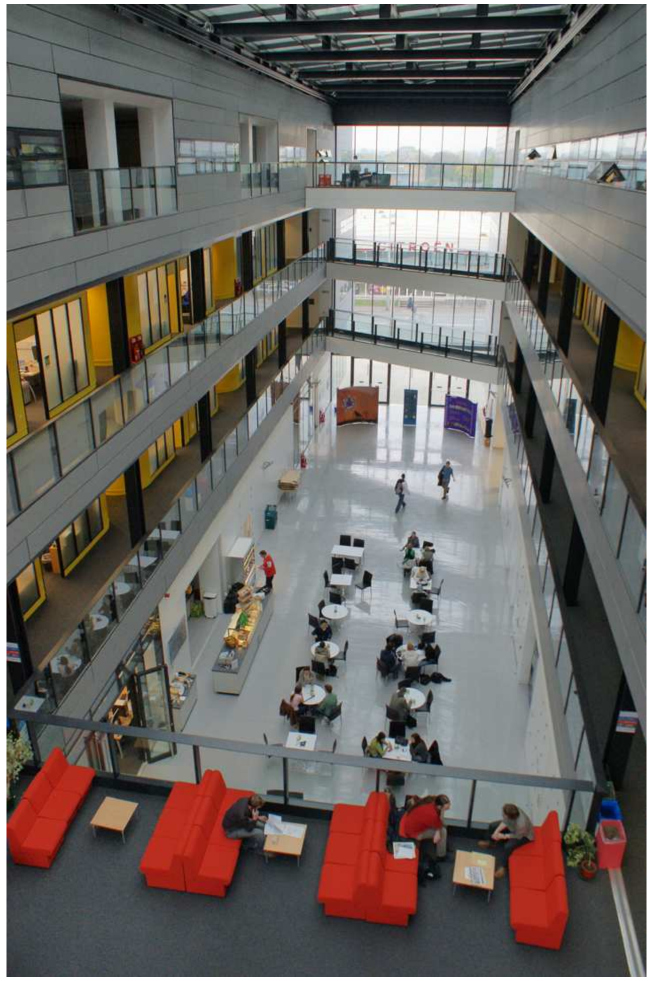

Figure 1: The atrium of the Alan Turing Building

User support facilities for MERLIN are now offered in a dedicated suite in the new building, where visitors will have better opportunities for interactions with JBCA academic and research staff as well as the benefits of closer transport links and proximity to Manchester itself. The proposal to host an ALMA Regional Centre node at JBCA, which would work closely with the *e*-MERLIN support facility, has been further reviewed by STFC. Of course, visitors will be welcome to travel out to Jodrell Bank to see the site or work with technical and operational staff.

This year, the 50th birthday of the Lovell Telescope has been celebrated with a number of special events at Jodrell Bank Observatory, including a spectacular sound and light show devised and produced by Alastair Gunn (VLBI Friend and RadioNet outreach) and a major press event on the anniversary of the launch of Sputnik. JBCA hosted a major international conference, "The Modern Radio Universe", which looked forward to the future development and scientific potential of SKA as well as current developments such as *e*-MERLIN, ALMA, EVLA and LOFAR. *e*-MERLIN featured prominently in many of the talks addressing topics from the formation of planets to the evolution of galaxies.

The discussion of ideas for the *e*-MERLIN Legacy Programme is now well underway. Following an announcement of opportunity in June, a kick-off meeting was held at JBO in July, attended by over 50 astronomers from the UK and Europe. A wiki site has been established: (http://www.merlin.ac.uk/e-merlin_legacy.html) and ideas for over 20 potential projects have been put forward and are being actively discussed. An evening meeting during the MRU conference in October, attended by about 80 delegates, provided an opportunity to present these projects to an international audience. Meetings for individual projects are now being convened but it should be stressed that these are very much open projects at an early stage of planning before the envisaged proposal deadline in April next year. The *e*-MERLIN Legacy Group, led by Prof Rob Ivison (ROE) is overseeing the process.

This degree of interest is an important expression of the scientific demand for the unique combination of sensitivity and high resolution at centimetre wavelengths which will be provided by *e*-MERLIN. It is providing new impetus to the science case for *e*-MERLIN and is being fed into two of the major reviews of current and future astronomical facilities being carried out by Astronet and the Science and Technology Facilities Council.

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3. *e*-MERLIN Update

- Optimisation of the L and C-band receivers continues with further tuning of the amplifiers and the completion of the reflective screening at the E-systems telescopes. The C-band receivers now achieve system temperatures below 30K throughout most of the 5.5-7.5 GHz band. Funding has been made available through the JBCA rolling grant for development of improved K-band LNAs and investigations of other receiver components to improve performance at C and K-band.
- Integration of the analogue electronics continues. The 1 GHz sampler boards are now being tested and are working well.
- The first optical prototype of the MERLIN phase transfer system has been extensively tested over installed *e*-MERLIN fibre spans of up to 110km and found to perform well. This work has been funded by SKADS, using *e*-MERLIN as a test-bed for SKA. Further tests to reduce potential long term phase drifts are continuing.

4.Topical News and Recent Science

CU Virginis – The star that thinks it's a pulsar!

Barry Kellett, Vito Graffagnino, Bob Bingham (RAL)
Tom Muxlow, Alistair Gunn (JBO).

CU Virginis (HD124224, HR5313, CU Vir) was discovered as a spectrum variable star in 1952 and as a stellar radio source in 1994. It was immediately recognised that it had a strong dipole magnetic field and that the dipole axis was close to perpendicular to the rotation axis (an oblique rotator). It is now known to be one of the brightest radio sources in the class of magnetic chemically peculiar (MCP) stars. It is detected from 1.4 to 88 GHz with flux densities of between 1 and 5 mJy, peaking at around 15 GHz. The dipole axis tilt results in our line of sight to the star passing through different parts of the stellar magnetosphere as the star rotates. CU Vir is especially suitable for observations because it is relatively close (80 pc) and has a short rotation period of just 12.5 hours (0.52 days).

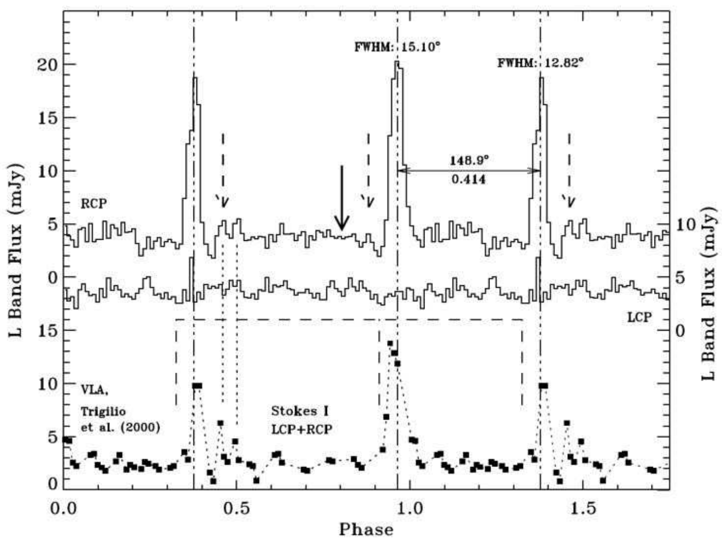

Figure 2: The L band flux density of CU Vir folded on the latest ephemeris of (1.75 cycles displayed). The MERLIN data are plotted as right and left circularly polarisation fluxes (RCP uses left-hand scale, LCP uses the right-hand scale). The two peaks were fitted with Gaussians to determine their separation and FWHM size. The dashed line marked by dots is the VLA L band data from Trigilio et al. (2000) which only fills ~50% of the phase bins. The arrow indicates the original predicted position for the burst at 0.96 phase. The data of Trigilio et al. (2000) have been shifted by 0.0525 in phase to make them line up with the MERLIN data.

We observed CU Vir with MERLIN at 1.658 GHz in May, 2006, on four consecutive nights (23rd – 26th). The main focus of our MERLIN observation was a ~100% right-hand circularly polarised (RCP) feature that had been seen in a VLA observation in 1998 (Trigilio et al., 2000). However, the enhancement was ~2 hours later than we had predicted prior to the observation. Even using the latest unpublished ephemeris for CU Vir leaves a discrepancy of ~39 minutes or 0.0525 in phase. The long-dashed lines above the Trigilio et al. data in Figure 1 indicates where the peaks would have appeared without the phase correction. Assuming the phase shift of 0.0525 between the MERLIN and VLA data is right it does bring features in the two data sets into good agreement. In addition to the two obvious enhancements, a pair of smaller feature around 0.45-0.50 in phase also seems to correspond in the two observations which are separated by almost exactly 8 years. Pyper and Adelman (2004) analysed many years of optical data on CU Vir and suggest one possible period solution for the available optical photometry that involved a 2.6 second period "glitch" around 1984.

There are approximately 5600 stellar rotations between the VLA and MERLIN observations, so a period slippage of 39 minutes translates to a period difference of an extra 0.4 seconds. If a second period glitch had occurred it would have taken place just over a year before the MERLIN observation. Pyper and Adelman (2004) also quote a continuously variable parabolic fit to the data which leads to a rate of change of rotation period as a function of period of 3.6×10^{-9} s/s or 11 seconds per century. The rapid rate of period change observed for a single, isolated star places CU Vir in amongst the fastest pulsars!

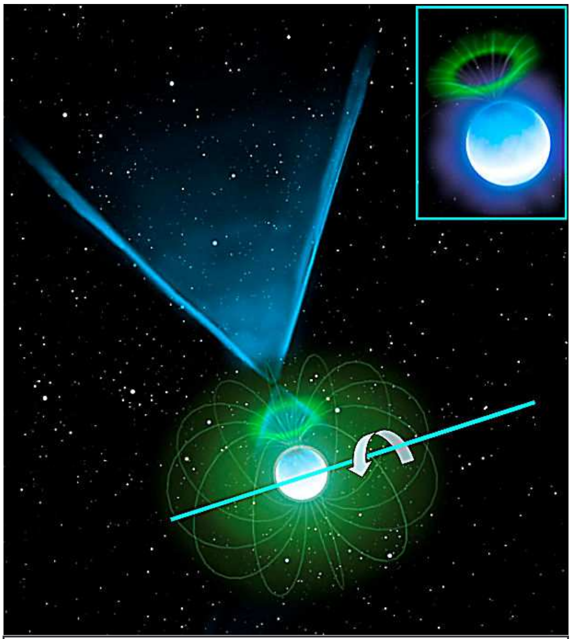

Figure 3: An artist impression of CU Vir showing the wide cone of radio emission emerging from one of the dipole magnetic poles. As the star rotates, the wide beam will pass across our line-of-sight and we will see two spikes of emission.
Picture: Copyright Mark A. Garlick

The MERLIN observation provided 100% phase coverage (much better than the previous VLA observation!). It clearly shows only two strong enhancements per rotation – each ~100% right-hand circularly polarized. It is possible that two (or more) weaker enhancements may also be present. The MERLIN data places each burst ~15^{o} "inside" the nominal perpendicular to the magnetic dipole axis. This strongly suggests that the enhancements can only be generated from one of the magnetic poles of the star.
CU Vir shows a rapid rate of period change in its optical photometric behaviour. The radio data also requires similarly rapid period changes to make them self-consistent. The very sharp and narrow radio enhancements make them ideal fiducial markers for tracking the rotation period of CU Vir.

References:

Pyper, D.M., & Adelman, S.J., The A-Star Puzzle, 224, 307 (2004).
Trigilio, C., Leto, P., Leone, F., Umana, G., & Buemi, C. A. & A., 362, 281-288 (2000).

Barry Kellett (b.j.kellett@rl.ac.uk)

IPS Measurements of Solar Wind Velocity

Andy Breen (Aberystwith), and Peter Thomasson (JBO).

Utilizing baseline lengths of up to 2000km between the telescopes of the MERLIN and EISCAT networks, Breen et al., have made a series of interplanetary scintillation (IPS) observations clearly resolving both fast and slow streams of the solar wind. This IPS technique uses widely spaced telescopes to measure rapid fluctuations in the apparent flux of distant quasars. By cross correlating the fluctuations measured by telescopes with large separations the speed of the solar wind can be investigated, and using longer baselines improves the ability to resolve flow regions with different velocities. In 2002, two of the EISCAT[1] (European Incoherent Scatter) telescopes at Kiruna (Sweden) and Sodanklya (Finland) were fitted with 1.4 GHz receivers. This allowed IPS measurements to be made at higher frequencies, over wider bandwidths, and on longer baselines (up to 2000 km when combined with MERLIN) than previous EISCAT-only observations which were carried out at 930 MHz.

This work has provided unequivocal evidence for two discrete modes of fast solar wind and, together with data from the LASCO instruments onboard the SOHO satellite, has helped to pinpoint their origins with the northern polar coronal hole and in an equator-ward extension to this polar hole. Long baseline IPS experiments such as these allow small scale turbulent motions within the solar wind to be studied in both temporal and spatial domains. The high velocity resolution obtainable from the extremely long baseline observations made by combined MERLIN plus EISCAT observations have provided new insights into the development of the large-scale velocity structure of the solar wind in interplanetary space.

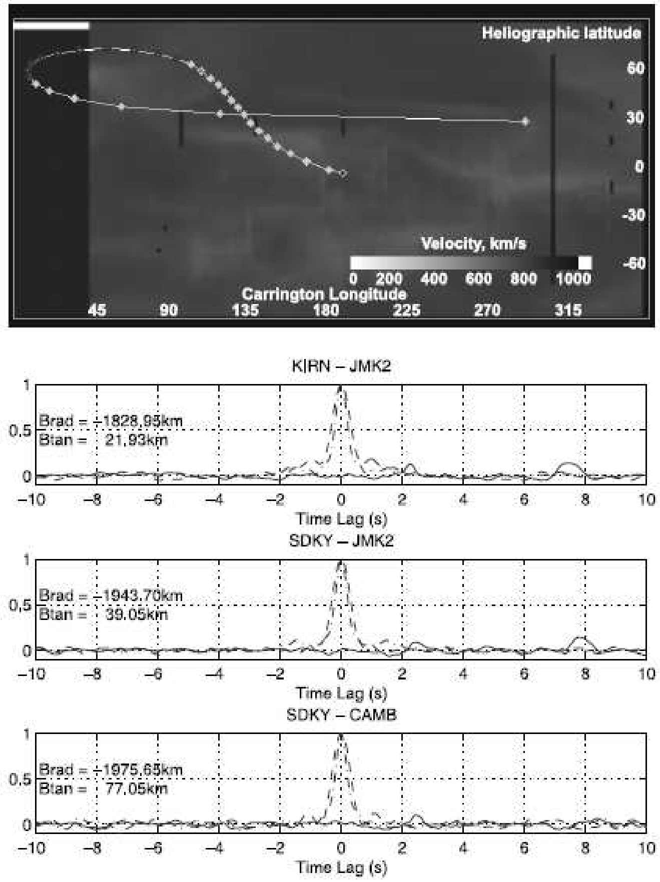

Figure 4: (Upper) Ray path for the observation of 0319 + 415 (3C84), ballistically projected down to 2.5 R at a constant velocity of 800 km s^{-1} and overlaid on a map of white-light intensity in the corona at 2.5 R off the east limb of the Sun constructed from LASCO C2 data taken during Carrington rotation 1989. (Lower) Correlation functions for observations of 0319+415 using (top to bottom) Jodrell Bank and Kiruna, Jodrell Bank and Sodankyla, and Cambridge and Sodankyla. The two peaks in the correlation functions correspond to plane-of-sky speeds of 792–816 and 234–248 km s^{-1}.

The combination of MERLIN and EISCAT measurements on long baselines produces substantial improvements in the ability of interplanetary scintillation observations to detect small variations in solar wind speed and direction. Breen et al. have exploited this to study the interaction of coronal mass ejections with the background solar wind and to detect a poloidal component in the interplanetary magnetic field, which they interpret as an equator-wards expansion of the fast solar wind - the expansion being most marked in low-latitude fast flow.

1 - EISCAT is an international organisation studying the magnetosphere and ionosphere of the Earth.

References:

Breen et al, 2006, Journal of Geophysical Research, 111, A8.

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