Effelsberg Newsletter

September 2014

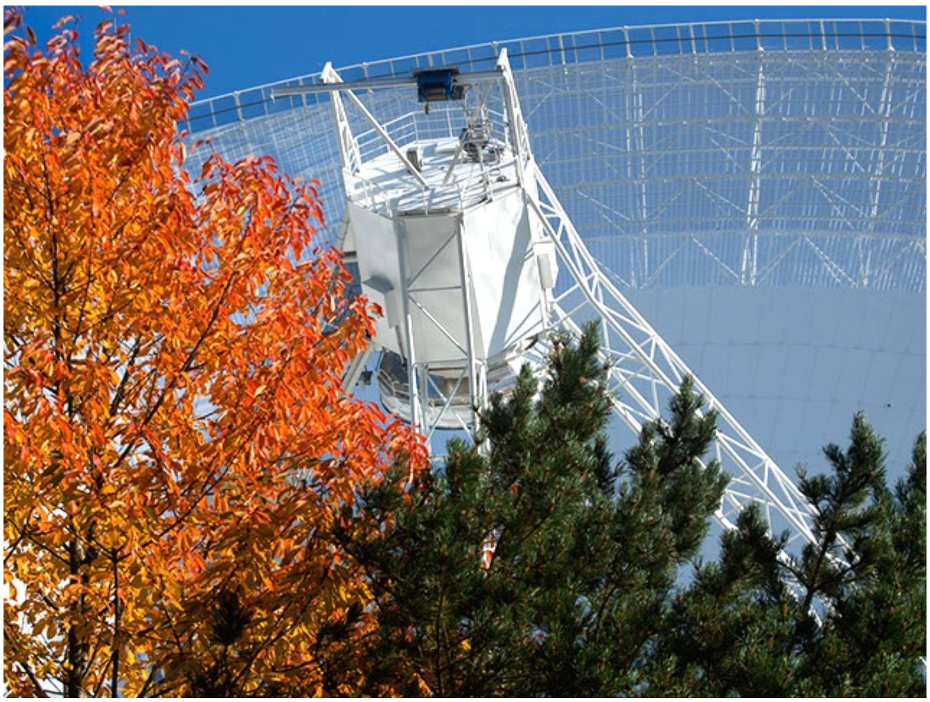


Photo Credit: Norbert Tacken

Call for Proposals

Deadline: October 6, 2014, 15:00 UT

Observing proposals are invited for the Effelsberg 100-meter Radio Telescope of the Max Planck Institute for Radio Astronomy (MPIfR).

The Effelsberg telescope is one of the World's largest fully steerable instruments. This extreme-precision antenna is used exclusively for research in radio astronomy, both as a stand-alone instrument as well as for Very Long Baseline Interferometry (VLBI) experiments.

Access to the telescope is open to all qualified astronomers. Use of the instrument by scientists from outside the MPIfR is strongly encouraged. The institute can provide support and advice on project preparation, observation, and data analysis.

The directors of the institute make observing time available to applicants based on the recommendations of the Program Committee for Effelsberg (PKE), which judges the scientific merit (and technical feasibility) of the observing requests.

Information about the telescope, its receivers and backends and the Program Committee can be found at

http://www.mpifr-bonn.mpg.de/effelsberg/astronomers

Observers are especially encouraged to visit the wiki pages!

Observing modes

Possible observing modes include spectral line, continuum, pulsar, and VLBI. Available backends are several state-of-the art FFT spectrometers (with up to 65536 channels per subband/polarization), a digital continuum backend, a number of polarimeters, several pulsar systems (coherent and incoherent de-dispersion), and two VLBI terminals (dBBC and RDBE type with MK5 recorders).

Receiving systems cover the frequency range from 0.3 to 96 GHz. The actual availability of the receivers depends on technical circumstances and proposal pressure. For a description of the receivers see the web pages.

How to submit

Applicants should use the new NorthStar proposal tool for preparation and submission of their observing requests. North Star is reachable at

https://northstar.mpifr-bonn.mpg.de

For VLBI proposals special rules apply. For proposals which request Effelsberg as part of the European VLBI Network (EVN) see:

http://www.evlbi.org/proposals/

Information on proposals for the Global mm-VLBI network can be found at

http://www3.mpifr-bonn.mpg.de/div/vlbi/globalmm/index.html

Other proposals which ask for Effelsberg plus (an)other antenna(s) should be submitted twice, one to the MPIfR and a second to the institute(s) operating the other telescope(s) (e.g. to NRAO for the VLBA).

After October, the next deadline will be on February 5, 2015, 15.00 UT.

By Alex Kraus

RadioNet Transnational Access Programme

RadioNet (see http://www.radionet-eu.org) includes a coherent set of Transnational Access programmes aimed at significantly improving the access of European astronomers to the major radio astronomical infrastructures that exist in, or are owned and run by, European organizations. Observing time at Effelsberg is available to astronomers from EU Member States (except Germany) and Associated States that meet certain criteria of eligibility. For more information:

http://www.radionet-eu.org/transnational-access

Time on these facilities is awarded following standard selection procedures for each TNA site, mainly based on scientific merits and feasibility. New users, young researchers and users from countries with no similar research infrastructure, are specially encouraged to apply. User groups who are awarded observing time under this contract, following the selection procedures and meeting the criteria of eligibility, will gain free access to the awarded facility, including infrastructure and logistical support, scientific and technical support usually provided to internal users and travel and subsistence grants for one of the members of the research team.

by Alex Kraus

TECHNICAL NEWS

Status of the New Secondary Focus K-Band Receiver

By Alex Kraus on behalf of the K-Band Rx project team

The new receiver has been installed in the telescope in January 2014 (see the last two issues of this newsletter).

Meanwhile, most of the observing modes have been successfully tested, including spectroscopy (yet with limited bandwidth, continuum and VLBI observations). We are still awaiting the installation of the complete hardware for the full band width-high resolution mode (which will allow to observe the receivers's full frequency range of 18-26 GHz with a frequency resolution of about 40 kHz - 0.5 km/s @26 GHz). The spectrometer cards and transducers for the optical fibres will be delivered in the next weeks. Hence, we expect the receiver to be fully available for science observations from November onwards.

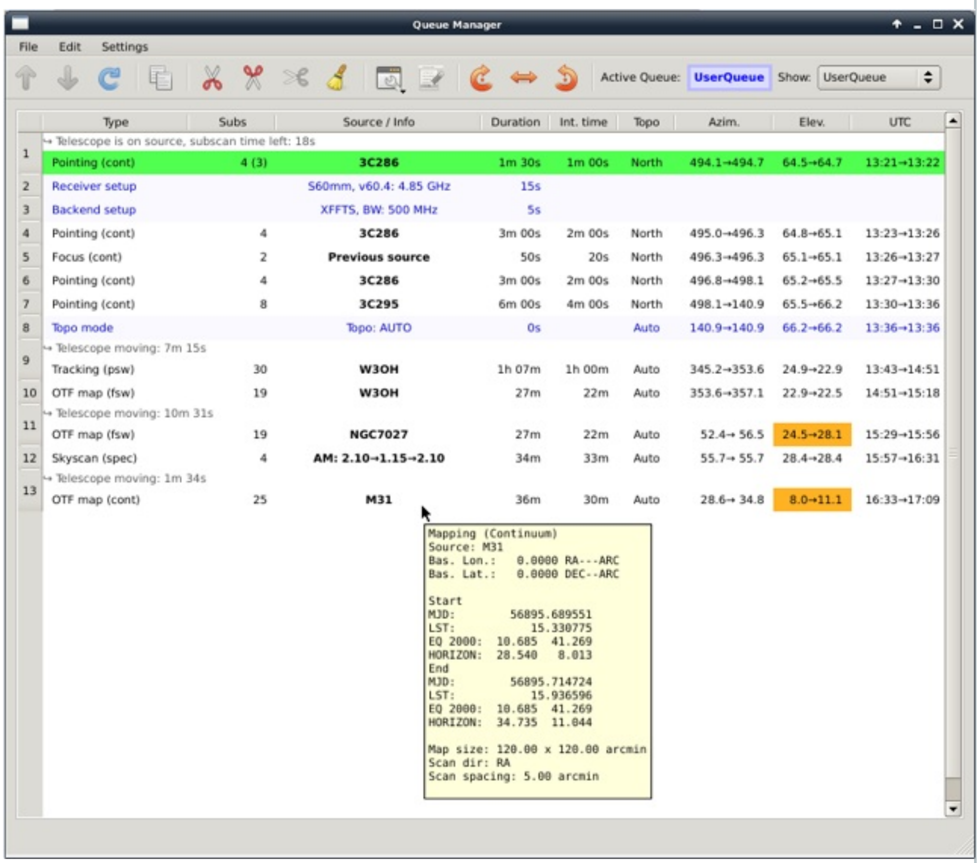
All new proposals for K-band observations will be considered to use the new receiver.

Left Image: K-Band frontend during lab commissioning. Space limitations require to remove the feed horns for testing. Small picture: CAD model of the K-Band Receiver incl. the feed horns. Credit to C. Kasemann

All Those Little Helpers: Part II

by Sven Brauch & Benjamin Winkel

In our last issue we started a new mini series of articles, presenting the various little tools and helpers we provide for our users. This time, we like to present you the brand-new:



Since a few years, starting with the new control system, users are invited to make use of our observing queue feature. It's plain and simple - just load as many measurement objects into the queue as you want, the system will then work on them subsequently. Until now, handling of objects in the queue was a bit tedious though, because the old queue manager allowed re-ordering of items in the queue in a very cumbersome way, only.

With the new completely rewritten queue manager proper drag'n'drop is now finally possible. And since we were at it, we also implemented a bunch of cool new features. Items are now more verbose (hint: have a look at the tooltips), one can duplicate items, drag'n'drop works with multiple items at once, etc. However, the most useful feature (at least from our point of view) is the prospected observing start/end time and telescope position for *all* items in the queue.

With this, it should be much more comfortable for the astronomer to optimize an observing session, avoiding duty cycles caused by unnecessary telescope re-positioning. Also, if for some item the prospected elevation goes below the Effelsberg horizon, the elevation-cell turns red (see screen-shot).

Science Highlights

VLBI Monitoring of Pleiades Stars: Hipparcos and Testing Stellar Models

By Carl Melis

Regular observation of stars in the Pleiades cluster are being conducted in concert with the Effelsberg, VLBA, Green Bank Telescope, and Arecibo antennas as part of a Very Long Baseline Interferometric astrometry program (Melis et al. 2013, Melis et al. 2014). With these observations the most accurate and precise cluster distance measurement to date has been obtained.

VLBI has emerged in the past several years as a reliable tool for delivering extremely high-precision astrometry (e.g., Loinard et al. 2007, Reid et al. 2009). Earth-sized baselines yield beam sizes of a milli-arcsecond and sometimes less while tight control of systematics has enabled positional measurements repeatable at the tens of micro-arcsecond level (Reid & Honma 2014). Such precision is capable of delivering accurate distances and plane-of-the-sky kinematics up to roughly 10 kpc distances from the Earth. Radio VLBI observations – which are referenced to distant, unmoving quasars – provide sky positions that are absolute as opposed to optical methods which are relative to background stars and must correct for motions of their stellar reference grid. Conducting observations in the radio further allows one to apply these techniques throughout the Milky Way Galaxy – even in the Galactic plane and dusty star-forming regions where optical and near-infrared observations would struggle or be impossible due to extinction.

The inclusion of Effelsberg in VLBI measurements enables much longer baselines than one can obtain with the other antennas alone and enhanced sensitivity. For faint sources – which all of our Pleiades targets are at an average flux density of 100 microJy – the improved resolution (typically 0.5 milliarcseconds in right ascension and 1.5 milli-arcseconds in declination) and gain in sensitivity are critical in obtaining high fidelity astrometry. This follows from the fact that the precision in centroiding point sources scales as the size of the point source profile divided by the signal-to-noise ratio of the point source detection. Thus, for a SNR~10 detection of a Pleiades target (a typical value), one could obtain astrometry precise at the ~100 micro-arcsecond level. A collection of such results over a year-long time baseline will yield a parallax accurate at the <1% level for a single Pleiades cluster member (see Figure 1).

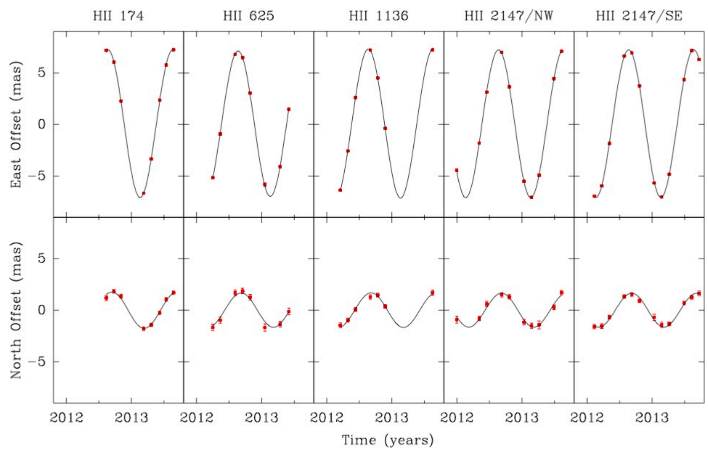


Fig. 1 Parallax fits to VLBI position measurements and associated random errors for five Pleiades stars. For each object the solid line is the best-fitting astrometric model that includes proper motion and parallax. The top panel curve and data points show right ascension angular offsets on the sky of the source position relative to an arbitrary reference position. The bottom panel curve and data points show declination offsets. Proper motion has been removed in the data points to accentuate the parallax motion. The modeled parallax for the four systems is: HII 1136, 7.382±0.031 mas; HII 174, 7.418±0.025 mas; HII 625, 7.223±0.057 mas; HII 2147 NW, 7.328±0.035 mas; HII 2147 SE, 7.319±0.027 mas.

It is the intrinsic qualities of VLBI discussed above that make it attractive in measuring a new distance to the Pleiades cluster. But what led to the necessity of this new measurement for a truly famous open cluster, observed since the time of the ancients? Extensive study of the Pleiades continues even to this day, and its properties are often distilled into empirical templates that are used to characterize other groups of stars at greater distances. One would expect that all critical astrophysical parameters for such an important sample of stars would be well determined. However, there still remains an open debate regarding the distance to the Pleiades.

A summary of distances obtained to date for the Pleiades cluster is shown in Figure 2. Most distances lie close to a value of 133 pc, but many of these are from physical models applied to cluster member temperature and brightness measurements. As pointed out by van Leeuwen (2009), these theoretical isochrones should be tested by distances obtained to the cluster from other methods instead of providing the cluster distance assuming our models are correct. The five orbital modeling distances are only for two Pleiades binary systems, and thus by themselves may not be representative of the entire cluster. Distances derived from cluster kinematics are not restrictive due to large uncertainties. This leaves trigonometric parallax, which shows a disagreement at the 3σ level between measurements made by the Hipparcos satellite for 53 Pleiades cluster members (120.2±1.5 pc, van Leeuwen 2009) and measurements made in the optical from the ground and in space (134.0±2.9 pc; weighted mean of Soderblom et al. 2005 and Gatewood et al. 2000). In aggregate, the non-Hipparcos parallax sample now contains 17 Pleiades cluster members when including the five VLBI targets shown in Figure 1.

What is shown in Figure 2 amounts to a 10% difference between the Hipparcos and average non-Hipparcos parallax distances. Should one adopt the Hipparcos distance as the correct one, the discrepancy would require revisions of stellar physical models that are quite significant (e.g., Pinsonneault et al. 1998, Soderblom et al. 1998). The implication of the Hipparcos result is that stars in the Pleiades are physically distinct from otherwise similar (but older) field stars and current physical models are incapable of accounting for this discrepancy suggesting a greater misunderstanding of the physics of young stars. A damning consequence of this would be that attempts to empirically determine distances to other clusters of stars using isochrone fitting anchored on the properties of the Pleiades cluster would be dubious at best.

In some sense the implications of the Hipparcos result make it comforting that it does not appear to be supported by continued attempts to determine new distances to the cluster. The VLBI cluster distance of 136.2±1.2 pc (discrepant with Hipparcos at the 6σ level) provides the most compelling evidence to date that the Hipparcos cluster distance is not correct. Perhaps more importantly, it validates previous non-Hipparcos parallaxes and orbit distance determinations which in turn provide confirmation of stellar physical models (of which the current state-of-the-art yields a cluster distance of 135.5±3.1 pc; An et al. 2007). It appears as though all is well in our understanding of the physics of young stars, but it couldn't be further from the truth for the Hipparcos distance measurement. Why the satellite – which performed so well for numerous nearby field stars – failed to deliver an accurate Pleiades cluster distance remains a mystery. Whether this has implications for

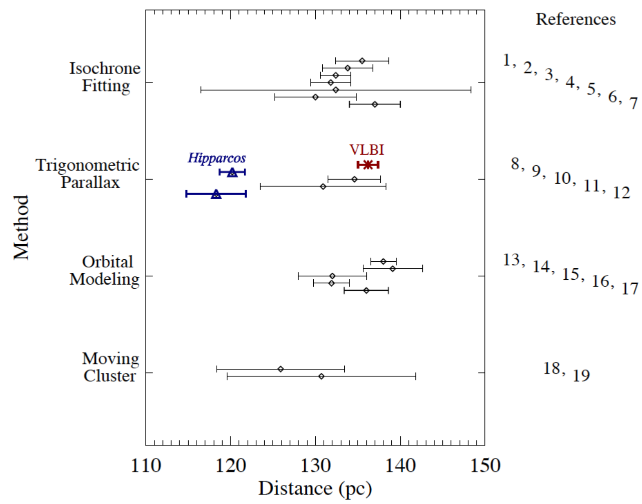


Fig. 2 Summary of Pleiades distances obtained through various methods. The red asterisk with distance near 136 pc is the new VLBI determination. The blue triangles near 120 pc are from two reductions of the Hipparcos data. Note that when combining the parallax measurements from Figure 1 to determine the VLBI cluster distance, an additional error component representing the uncertainty on where each source lies relative to the cluster center is added in quadrature to the parallax error. This cluster depth uncertainty is now the dominant error term in determining the distance to the Pleiades cluster. References – (1) An et al. 2007, (2) Percival et al. 2005, (3) Stello & Nissen 2001, (4) Pinsonneault et al. 1998, (5) Giannuzzi 1995, (6) van Leeuwen 1983, (7) Nicolet 1981, (8) Melis et al. 2014 submitted, (9) van Leeuwen 2009, (10) Soderblom et al. 2005, (11) Gatewood et al. 2000, (12) van Leeuwen 1999, (13) Groenewegen et al. 2007, (14) Southworth et al. 2005, (15) Zwahlen et al. 2004, (16) Munari et al. 2004, (17) Pan et al. 2004, (18) Röser & Schilbach 2012, (19) Narayanan & Gould 1999.

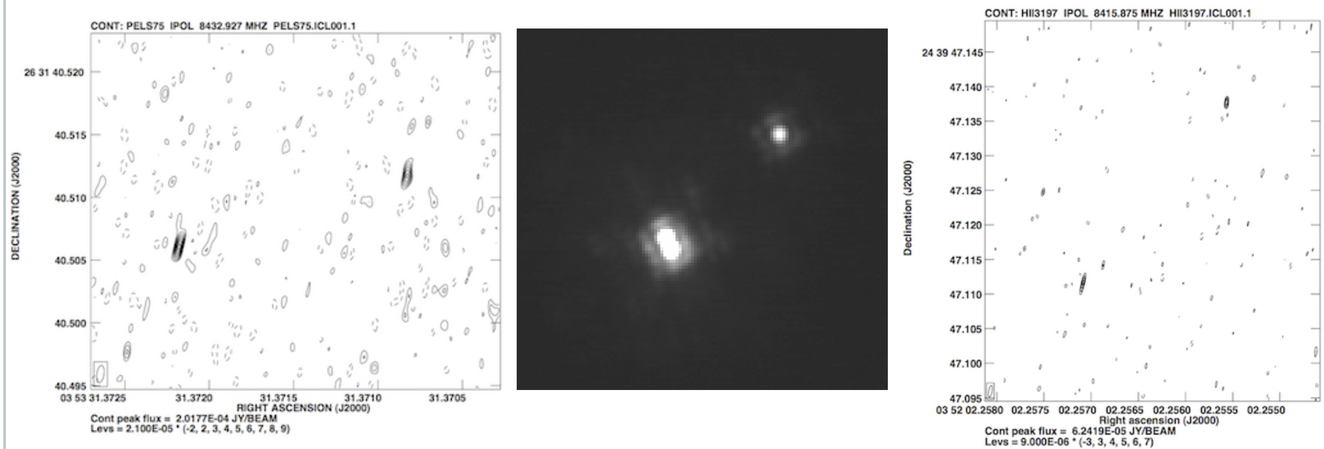


Fig. 3 Pleiades binary systems resolved with VLBI that will yield precise masses through orbital fitting. Left Panel: PELS75 resolved into a ~19 milli-arcsecond (2.5 AU projected separation) binary with VLBI. A full orbit and absolute masses for each component of the binary system will be determined using VLBI position measurements (mostly of the primary in the system) and optical spectroscopic observations. Middle and Right Panels: Keck near-infrared adaptive optics imaging in 2011 resolves the HII 3197 triple system while VLBI imaging in 2013 detects both components of the inner binary. This triple system was first discovered in the 1990's and has now been monitored over a full orbit. Full orbital modeling will benefit immensely from a precise distance to the system from VLBI and from repeated VLBI detections of both inner members of the triple system as they progress through their periastron passage.

Gaia, the successor to Hipparcos, cannot be commented on until some understanding of what went wrong with the Hipparcos Pleiades measurement is obtained.

As of the writing of this report the Pleiades VLBI program is nearly 90% complete and slated to finish in early 2015. Although a cluster distance has been determined, there are additional interesting results still to come. Final parallaxes for a sample of eight Pleiades systems will be obtained yielding a cluster parallax from radio astrometry alone with accuracy that will be unrivaled until Gaia produces its final catalogs. Possibly more valuable than an incremental update of the cluster distance is the determination of binary orbits for at least two VLBI Pleiades systems (Figure 3). These binary systems will have complete orbital solutions from VLBI data, infrared imaging, and optical spectroscopy and hence masses for both stars in each binary system will be extracted. For the Pleiades this will represent a doubling of the number of high fidelity cluster member masses and will be instrumental in stress testing physical models for young stars.

REFERENCES

An et al. 2007, ApJ, 655, 233
Gatewood et al. 2000, ApJ, 533, 938
Giannuzzi 1995, A&A, 293, 360
Groenewegen et al. 2007, A&A, 463, 579
Loinard et al. 2007, ApJ, 671, 546
Melis et al. 2013, IAU Symposium 289, 60
Melis et al. 2014, Science 345, 1029
Munari et al. 2004, A&A, 418, L31
Narayanan & Gould 1999, ApJ, 523, 328
Nicolet 1981, A&A, 104, 185
van Leeuwen 1983, Ph.D. Thesis
van Leeuwen 1999, A&A, 341, L71
van Leeuwen 2009, A&A 497, 209
Zwahlen et al. 2004, A&A, 425, L45

Link to the publication:

Carl Melis et al., Science 345, 1029 (2014)

http://www.sciencemag.org/content/345/6200/1029.full.pdf

A Dynamically Driven Transition from Atomic to Molecular Intermediate-Velocity Clouds

By Jürgen Kerp & Tobias Röhser

Milky Way halo clouds are detectable via their emission of 21 cm line radiation of neutral atomic hydrogen (HI). Some of these clouds move with radial velocities which are incompatible with simple models for the galactic rotation. These objects are known as either intermediate- or high-velocity clouds (IVCs or HVCs). Even today, their role in the evolution of our Galaxy as a whole is unclear.

Interstellar absorption line spectroscopy reveals that IVCs are located closer to the galactic disk while HVCs are on average at distances of tens of kpc; moreover, IVCs contain larger amounts of processed matter than HVCs. Accordingly, observations suggest that the dominant fraction of IVCs are part of a galactic fountain cycle: supernova explosions expel hot enriched gas into the galactic halo forming in-falling neutral IVCs eventually. Such impacts fuel the Milky Way Galaxy and trigger star formation activity.

We quantitatively analyse HI line emission and far-infrared (FIR) dust continuum radiation (Figure 1). This allows us to distinguish between the atomic and molecular content of the IVCs. A linear correlation is well established between the total amount of hydrogen and the associated FIR dust emission. If some of the atomic hydrogen has turned into molecular (H_2) gas, an excess in the HI-FIR correlation is detected. Hence, from the observed FIR excess one can infer the distribution and amount of H_2. We apply this method to study the distribution of H2 at high galactic latitudes. In particular, we are interested in H2 gas not quantitatively traced by carbon-monoxide (^{12}CO) data – denoted as "CO-dark gas". For this aim we use data from the Effelsberg-Bonn HI Survey (EBHIS) and the Planck satellite.

We identify two spatially neighbouring IVCs that appear as twins concerning their HI properties but opposing in terms of their HI-FIR correlation: One is FIR under-luminous while the other is FIR bright. The FIR excess emission indicates a large H_2 content which so far is rarely observed in IVCs. Independent of the FIR, the presence of H_2 is confirmed by CO emission associated with the cloud.

The observed difference in FIR intensity is attributed to their different stages in the transition from pure atomic to molecular clouds. This transition is thought to be triggered by the compression of the clouds due to their motion relative to the ambient galactic halo medium. The ram pressure interaction increases the gas pressure within the clouds leading to an enhanced formation rate of H_2, or equivalently to a shorter H_2 formation time. In consequence, molecular gas falls onto the Milky Way disk.

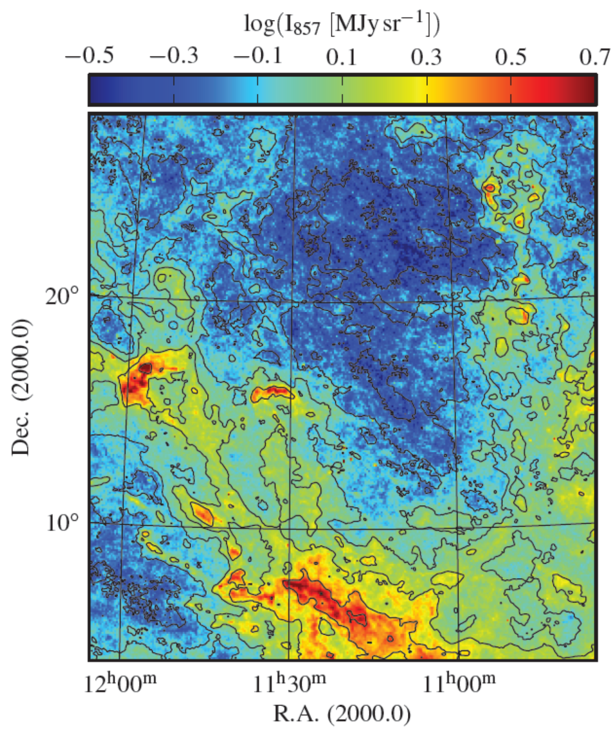


Figure 1: The 857 GHz intensity map from Planck. The contour lines denote HI column densities from EBHIS. The tight correlation between HI gas and FIR dust emission is evident. Towards this field of interest the IVC HI-twins are observed.

These IVCs are located in the galactic disk-halo interface region, about 500 pc above the galactic midplane. From the EBHIS data we infer linear sizes of the IVCs of a few parsec only. Thus, these clouds are too small to be observed in other galaxies even with ALMA. Like a cosmic "rain shower" IVCs might fuel the interstellar gas of the Milky Way with sub-solar metallicity gas. A full-sky study of EBHIS and Planck data is ongoing and might disclose the importance of this finding.

Reference**: A dynamical transition from atomic to molecular intermediate-velocity clouds**, T. Röhser, J. Kerp, B. Winkel, F. Boulanger, G. Lagache, 2014 A&A, 564A, 71R

Who is Who in Effelsberg?

Rainer Sachert

Born in Cologne, I grew up in the "Südstadt" (a quarter south of the Cologne city center) and in the district "Zollstock". As a member of the competitive sports department in the largest and oldest swimming club in Cologne, the SV-Rhenus Cologne, I participated in national and international swimming competitions and water polo tournaments.

Due to my technical interests I started my apprenticeship at Leybold Heraeus, a company which designs and builds e.g. vacuum technology as well as scientific experiments (for schools and universities). My subsequent professional activities in the "Physics Department" and later in the "Electronics Manufacturing" of Leybold-Heraeus led me closer to the - at the time – new and highly topical semiconductor and micro computer technology.

I finished my studies of electrical engineering with specialization in „Technical Computer Science“ at the University of Siegen (Departement Gummersbach) in 1982. The work for my diploma thesis „Design, Construction and Test of a Logic Analyzer for use on the Microprocessor System ‚MIZE‘ with the Intersil Microprocessor IM6100“ was done in the Digital Laboratory of the MPIfR in Bonn. After this I got the offer to work at the Effelsberg observatory on the modernization of the contactor control technology with modern SPC (stored program control) techniques. Since I had visited the 100-m telescope several times already in the 1970s and had been impressed by the dimensions and the technology of this telescope, I did not hesitate to accept the offer and started to work in Effelsberg on April 15, 1983.

After finishing this project in Effelsberg I returned back to the digital group in Bonn to work on the construction and commissioning of several autocorrelator systems, e.g. the multibeam correlator MACS for the JCMT at Hawaii. Then, in 1998, I took my new position as "operating engineer (for the electrical system)" at the Effelsberg observatory.

With much enthusiasm, I was involved (in large part as an initiator) on many projects of technical modernization of the telescope- and institute-infrastructure and of structural renewals of the telescope control and drive technology. My motto was and is: There is plenty to do, because stagnation is regression!

Public Outreach

School Academy of Bonn University on Visit to Effelsberg

By Norbert Junkes

On Tuesday, August 05, 2014, the Bonn School Academy for highly gifted pupils in science visited Effelsberg radio observatory in the second consecutive year. The excursion to the Effelsberg station is part of a workshop in Physics and Astronomy at Bonn University.

Fig. 1: *Participants and supervisors of the school academy of Bonn University at their visit at the Effelsberg site close to the visitors' pavilion. Photo: Tobias Jungk, Bonn University.*

The program at the observatory includes an introductory talk at the visitors' pavilion and later on a guided tour to different places in the radio observatory. They include the viewing spot in the direct vicinity of the 100m radio telescope which is accessible on a newly installed zic-zac pathway from the pavilion, the Effelsberg station of the International LOFAR Telescope, and also the control room of the observatory (see Fig. 2 below).

The program for visitors at the Effelsberg Radio Observatory is usually confined to the pavilion where one-hour talks are offered for very different groups of visitors. The talks include a description of the telescopes on site (with the main impact on the 100m radio telescope which is in direct view form the pavilion). In the talks we can show a film with a tour to the very top of the telescope (almost 100 meters above the ground). Another important part is the description of the science with radio telescopes and the difference to more generally known optical telescopes.

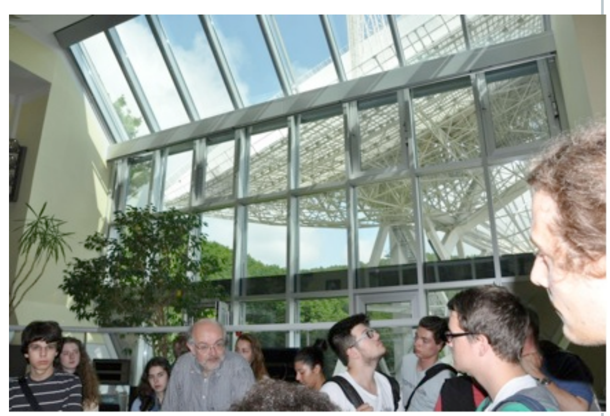


Fig. 2: *Visitors of the School Academy in the control room of the Effelsberg Radio Observatory. Photo: Tobias Jungk, Bonn University.*

For specific groups like the school academy workshop visits or e.g. astronomical excursions of student groups from universities there is the extended program also showing the observatory.

The talks are offered seven months per year, from April to October, Tuesday to Saturday. Pre-registration is possible via +49 2257 301-101 (Mrs Franzen or Mrs Wilfert). Talks are usually given in German language, English talks on request are also possible.

Link: School Academy 2014 at Bonn University
http://www.schuelerlabor.uni-bonn.de/veranstaltungen/bonner-schuelerakademie-physik-astronomie/2014/bonner-schuelerakademie-2014

Contact the Editor: Busaba Hutawarakorn Kramer

Max-Planck-Institut für Radioastronomie,
Auf dem Hügel 69, 53121-Bonn, Germany

Email: bkramer@mpifr-bonn.mpg.de

Website: http://www.mpifr-bonn.mpg.de