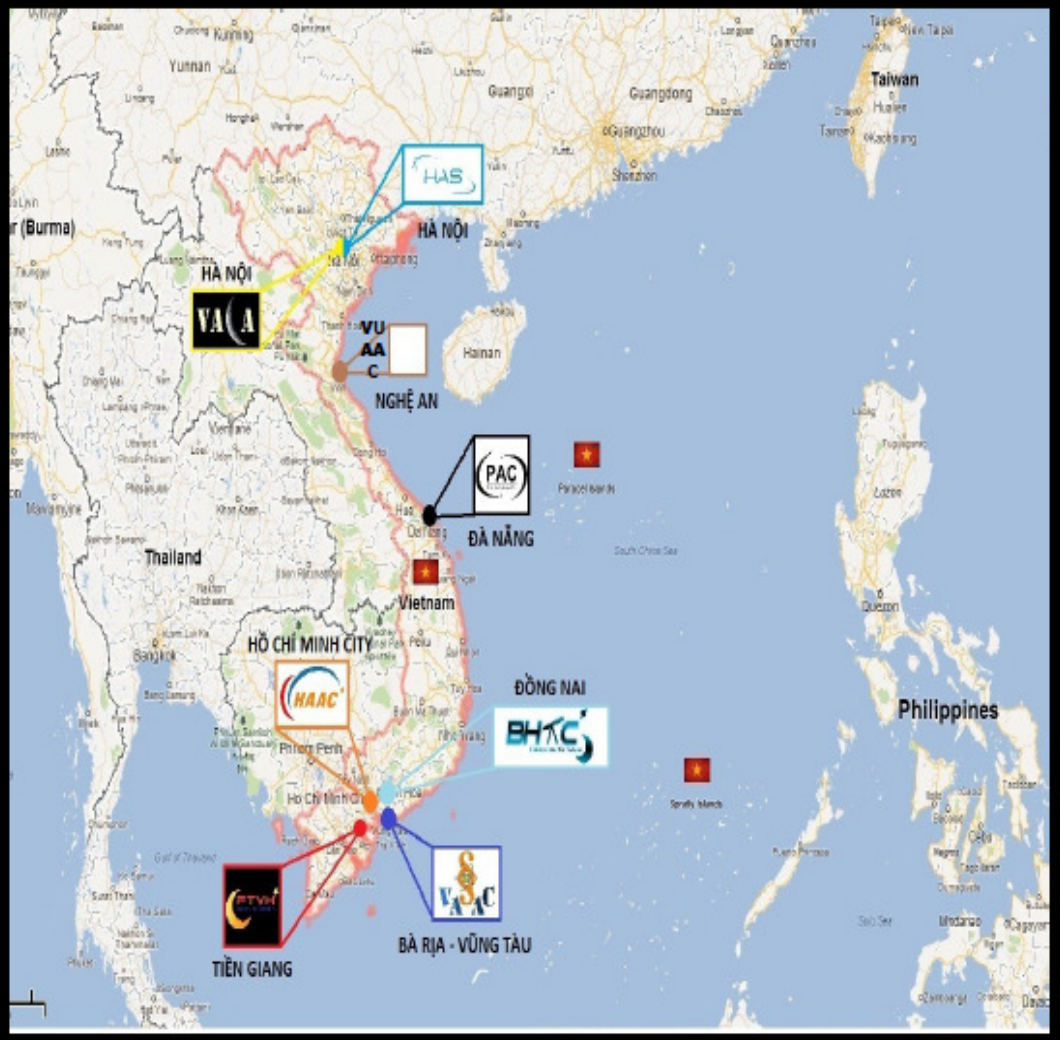
Radio astronomy in Vietnam: Recent developments

Pham Ngoc Diep
Institute for Nuclear Science and Technology, Hanoi, Vietnam

Chiang Mai, January 2014

Introduction



Việt Nam

- Southeast Asia
- 331 thousand km2
- 90 million inhabitants
- Capital: Hanoi
- Largest economic city: HoChiMinh

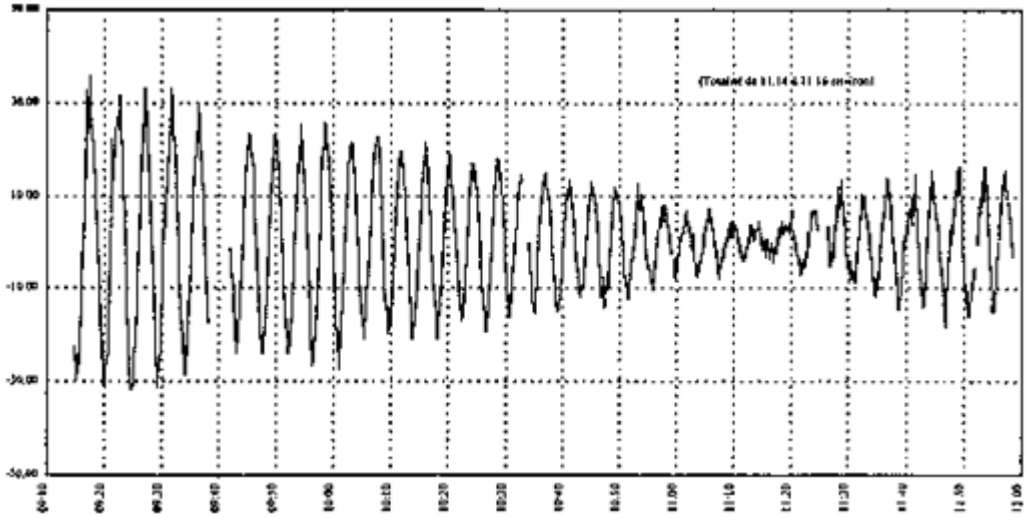
Professor Nguyen Quang Rieu
Founding father of radio astronomy in Vietnam

Nguyễn Quang Riệu (1932, Hai Phong) is an oversea Vietnamese (resident in France); radio astronomer at Paris-Meudon Observatory, professor at Sorbonne University (Paris).

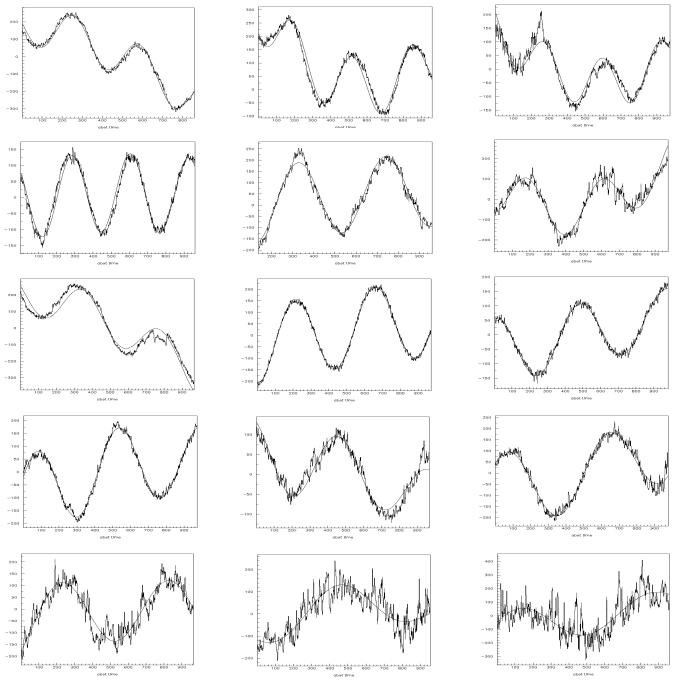
While in France where he spent his scientific life, he made major contributions to radio astrophysics (synchrotron radiation, maser, rare molecules,…). He understood early the interest in promoting it in Vietnam, both because of its scientific potential and its suiting well the needs and constraints specific to the country.

He is one of the first researchers who are very active in promoting astronomy to young Vietnamese.

On the occasion of the 1995 solar eclipse, Rieu came to Phan Thiet to observe it using a 610 MHz radio interferometer using a pair of Yaggi antennas.



The Yaggi interferometer was left in Vietnam as a gift to train students. One of us used it for his master thesis to observe the Sun.



Research in
Radio Astronomy in Vietnam

DINH VAN TRUNG

BS in Ha Noi, MS and PhD in Paris (1998),
Postdoc in Taipei, Inst. Astron. Astrophys (1999-2003),
2003 assistant research fellow in Taipei, Inst. Astron. Astrophys.
Now associate Professor and Researcher at Hanoi IOP.

Research Interests

Stars and their circumstellar envelopes
Molecular gas in starburst galaxies
Molecular spectroscopy
Radiative transfer in astronomical environments

DVTrung: the asymmetry in the envelope around the carbon star CIT

HC3N (cyanoacetylene) J=5–4 and 7 mm continuum emission distribution at high angular resolution

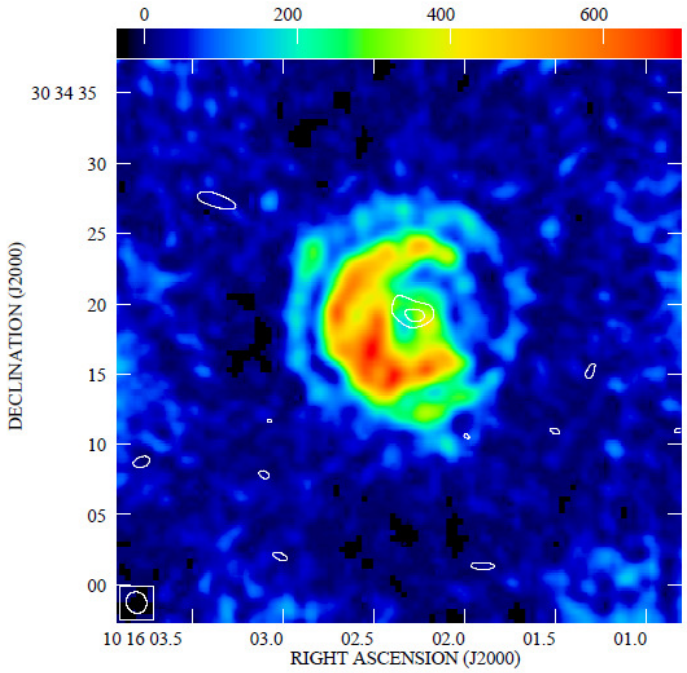
(1) a faint outer spherical shell

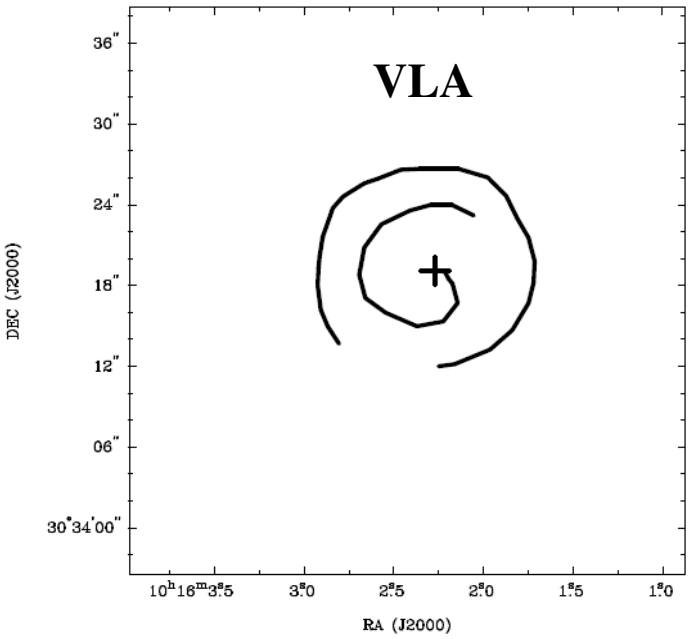
(2) a thick and incomplete inner shell resembling a one-arm spiral.

multiple shells → mass loss **highly anisotropic and episodic**.

excitation modeling of HC3N → abundance of HC3N **unusually high** in CIT 6 in comparison to the well known carbon star IRC+10216.

They suggest that the observed **spatial distribution of the emission** and the inferred **high abundance of HC3N** might be caused by a **binary companion**.





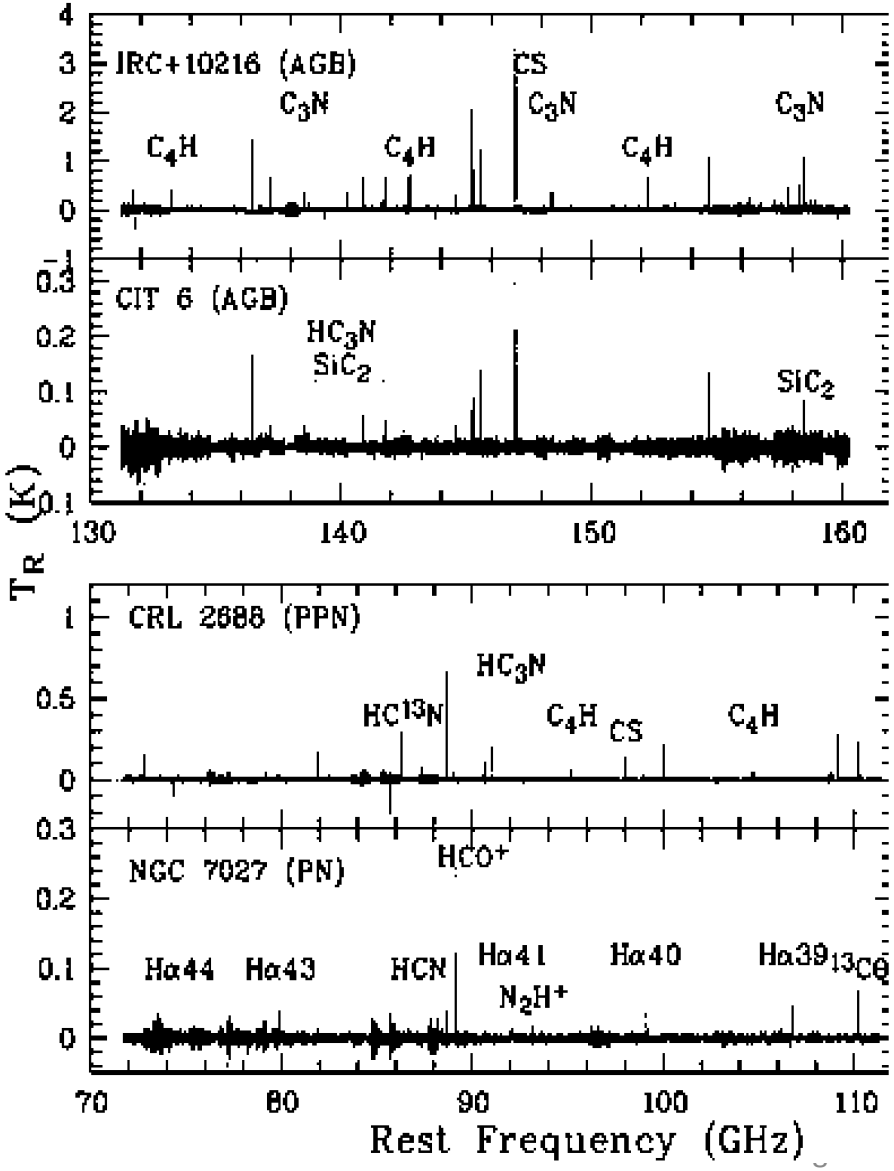
DVTrung: Molecular lines in the envelopes of evolved stars

Sample: 3 AGB stars, one PPN and one young PN, using Arizona Radio Observatory 12 m (71-161 GHz) and 10 m (218-268 GHz) telescopes. Sensitivity T_R<10 mK; R~1 MHz.

>500 emission features are detected in the survey → sources of different evolutionary stages have **remarkably different chemical composition**.

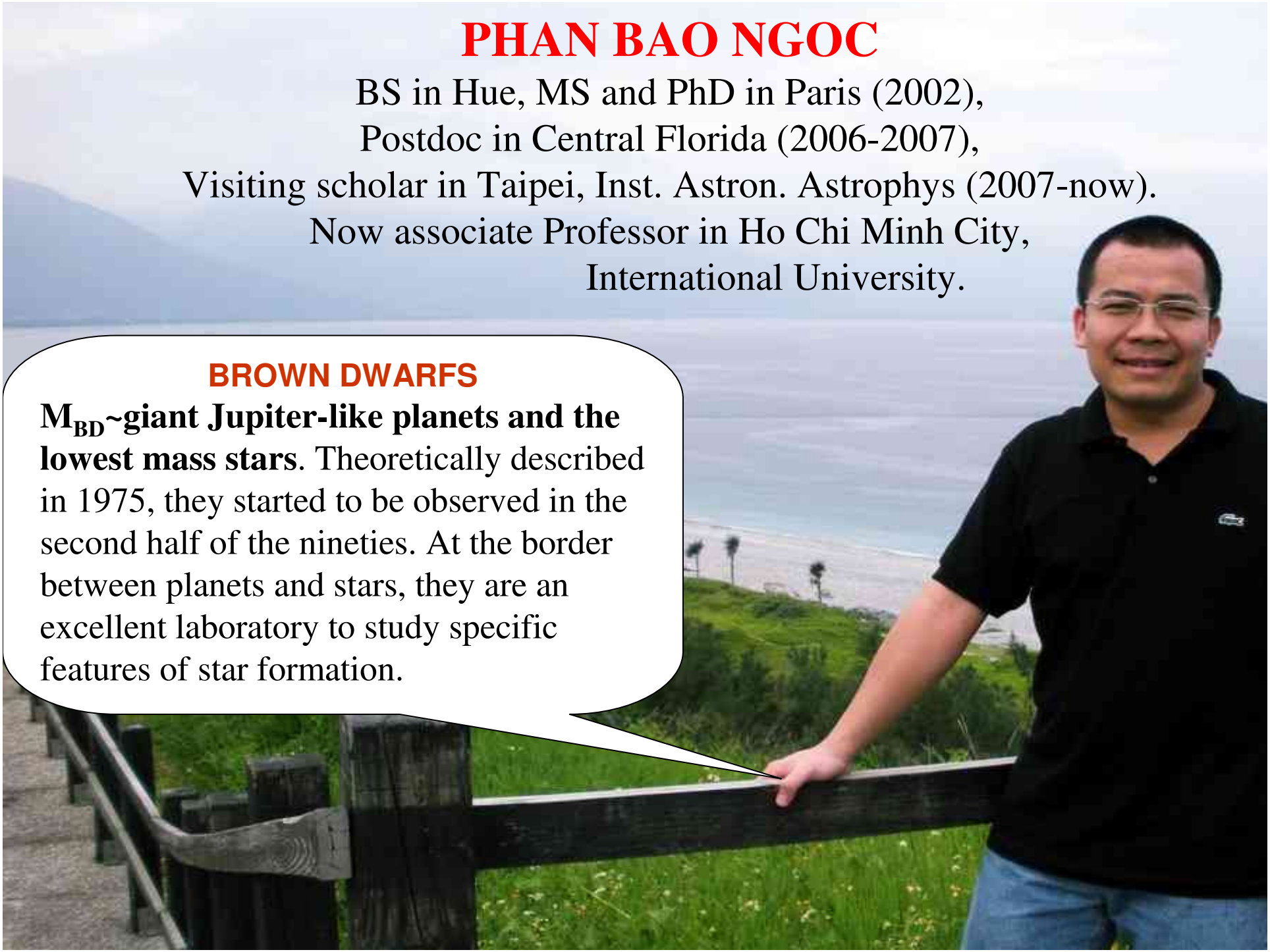
These differences can be attributed to the changes of the role that **dust, stellar winds, shock waves, and UV/X-rays** from the central star play in different evolutionary stages.

These results provide significant constraints on models of circumstellar chemistry.



PHAN BAO NGOC

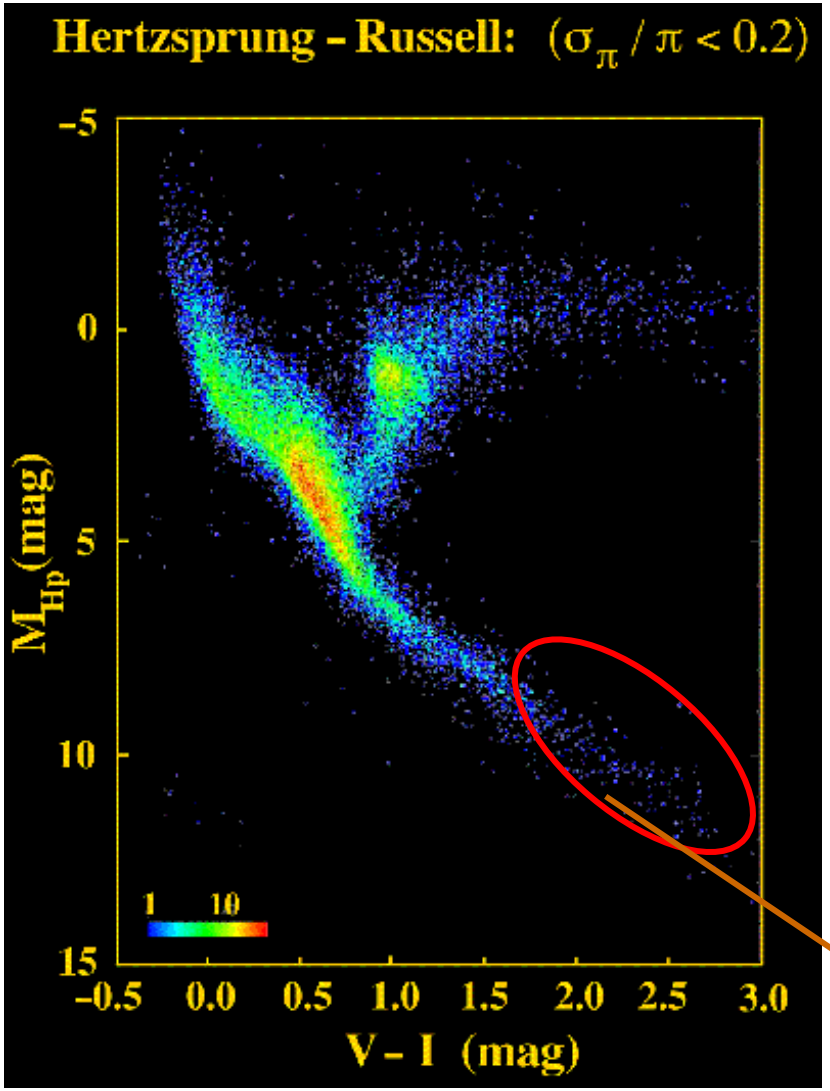
BS in Hue, MS and PhD in Paris (2002),
Postdoc in Central Florida (2006-2007),
Visiting scholar in Taipei, Inst. Astron. Astrophys (2007-now).
Now associate Professor in Ho Chi Minh City,
International University.

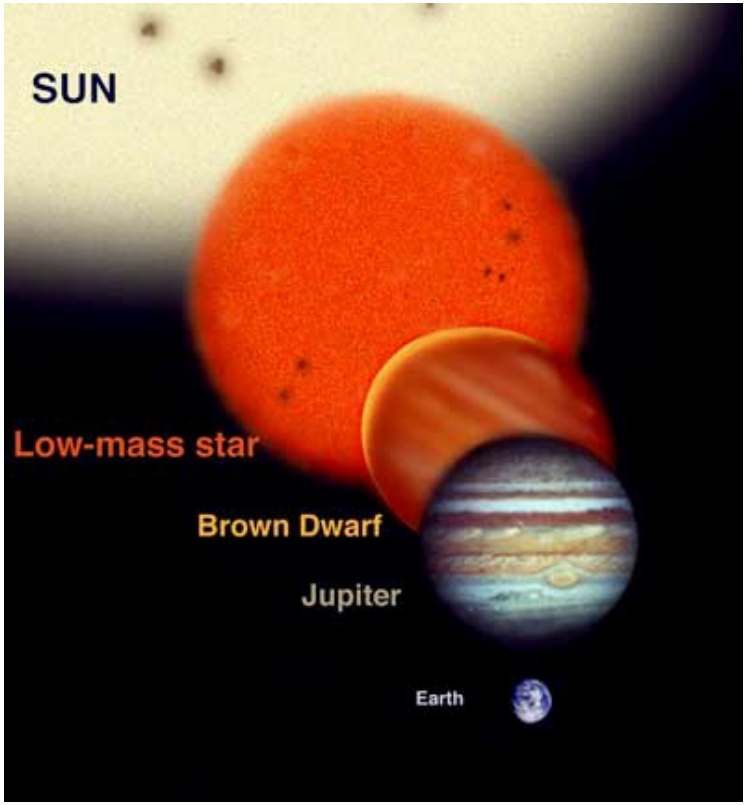


BROWN DWARFS

M_{BD}~giant Jupiter-like planets and the lowest mass stars. Theoretically described in 1975, they started to be observed in the second half of the nineties. At the border between planets and stars, they are an excellent laboratory to study specific features of star formation.

Brown Dwarfs





Brown Dwarfs

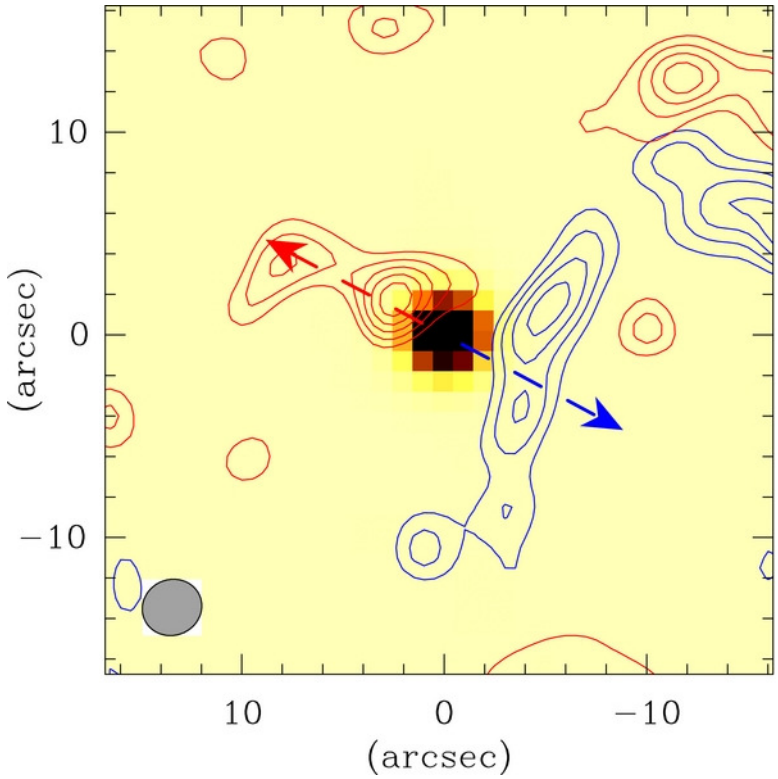
In collaboration with foreign teams, and using several radio astronomy facilities, PBN has contributed answers to major current questions:

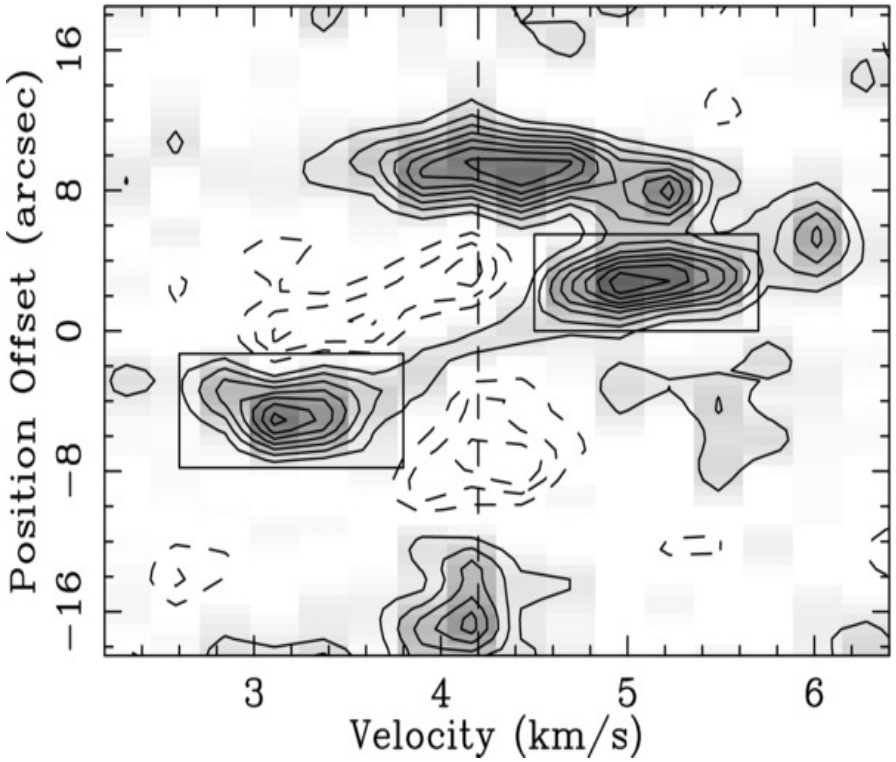
How do brown dwarfs form? How is their magnetic field morphology?
Does spectral type "Y" exist? What are the properties of their planets?

A recent example: MHO 5, 90 M_J, Taurus

Phan-Bao et al. 2011, ApJ

Observation of molecular outflow in CO J=2→1 MAP (230 GHz)





Summary of the study

- BD Outflow Properties:
  - Compact: 500-1000 AU
  - Low velocity: 1-2 km/s
  - Outflow mass: 10^{-4}-10^{-5} $M_\odot$ (low-mass stars: 10^{-1} $M_\odot$)
  - Mass-loss rate: 10^{-9}-10^{-10} $M_\odot$/yr (low-mass stars: 10^{-7} $M_\odot$/yr)
  - Episodic: active episodes of t ~ 2000-5000 yr
- What we can learn from our observations:
  - BD outflow is a scaled down version (a factor of 100-1000) of the outflow process in stars
  - Supporting the scenario that BDs form like stars
  - BD outflow properties are used to identify/study BD formation at earlier stages

Vietnam Astrophysics Training LaboratorY (VATLY)

3 postdocs, 3 phd students, 1 master student

research at home using a 2.6 m (1.4 GHz) radio telescope

and in collaboration with Paris on AGB stars using Plateau de Bure and VLA data

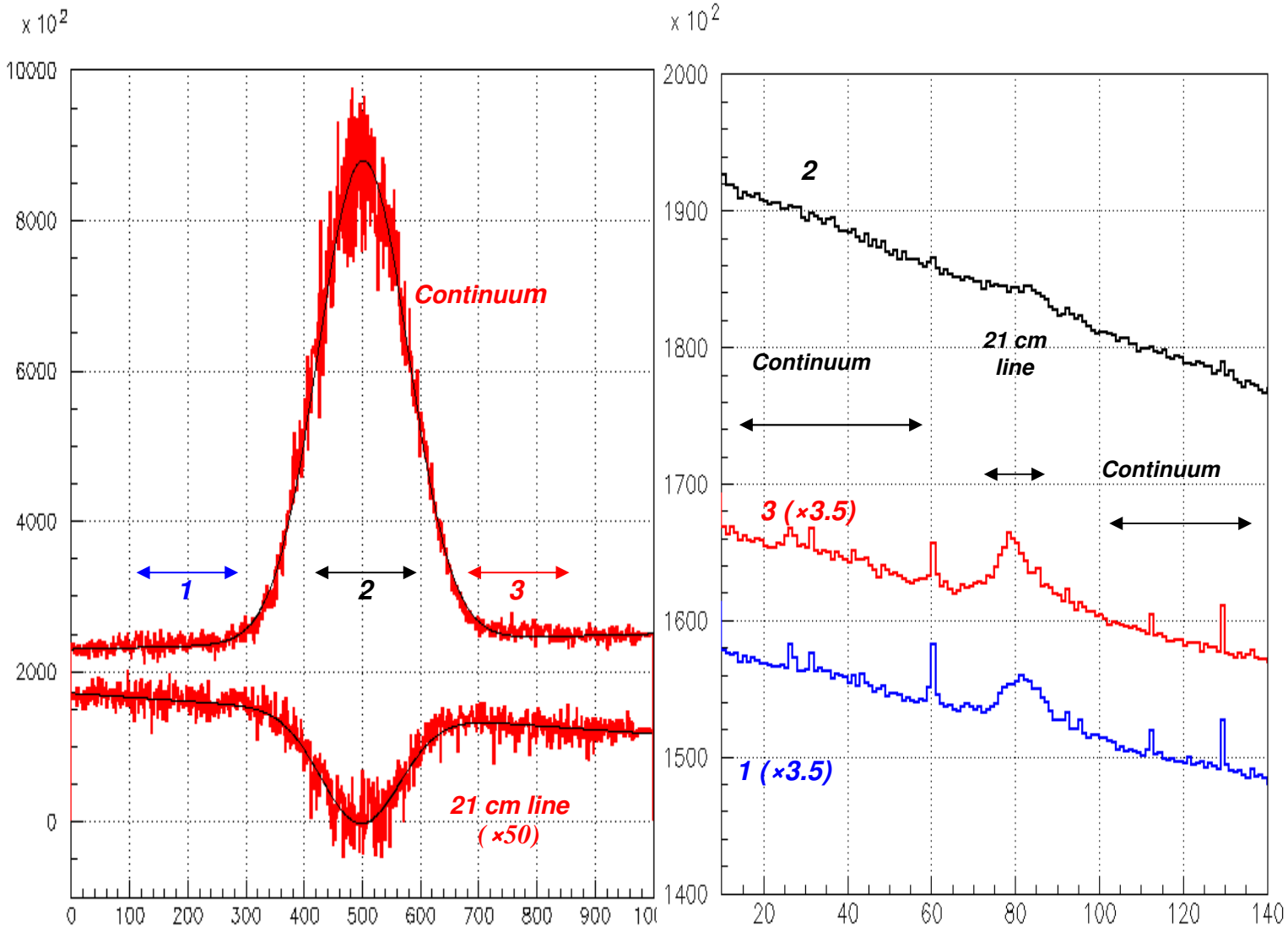
and in coll. with Toulouse on host galaxies of remote QSOs using PdBI and later ALMA.

Three years ago, we acquired a 2.6 m diameter radio telescope tuned on (and around) the 21 cm hydrogen line. It has been used to map HI in the disk of the Milky Way and is currently taking data on the Sun at its maximum of activity. Frequency spectra are collected every 8 seconds displaying very clearly the 21 cm line.

•pointing accuracy of ~ 0.3^{o} (after applying corrections of ~1^{o})

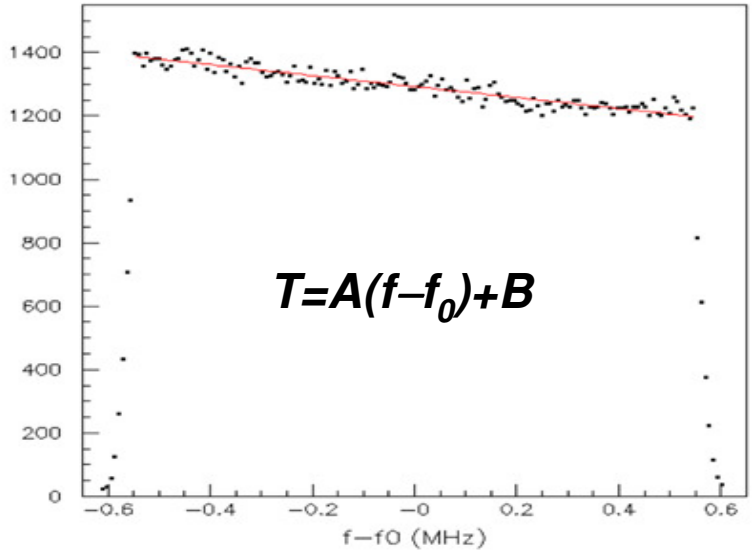
•the size of the lobe (FWHM) measured to be 5.5±0.3^{o}

Drift scans across the Sun: General features



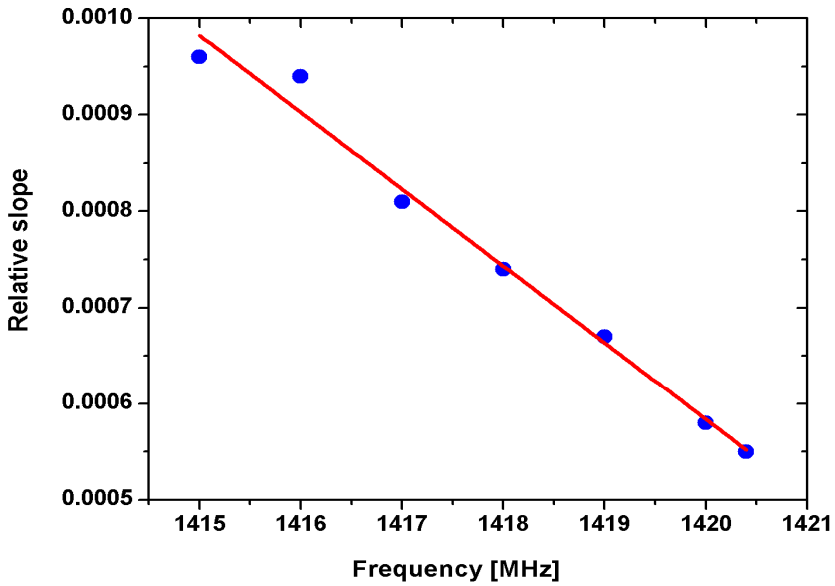
Frequency spectra measured before (blue) during (black) and after (red) Sun crossing.

Response of the SRT

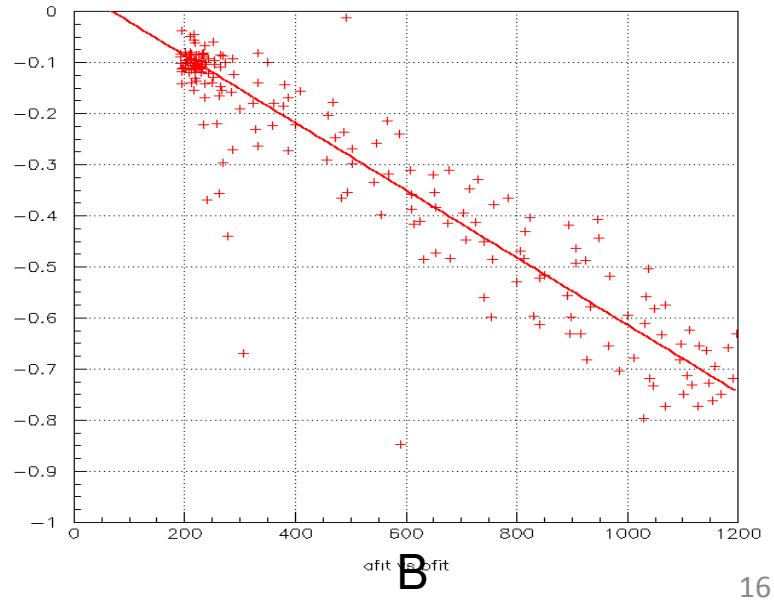


The relative gain drop per frequency channel is 0.55‰ (*i.e.* ~70 ppm/kHz) at a central frequency of 1420.4 MHz.

A non-linearity of 4.6‰ on the Sun is observed.



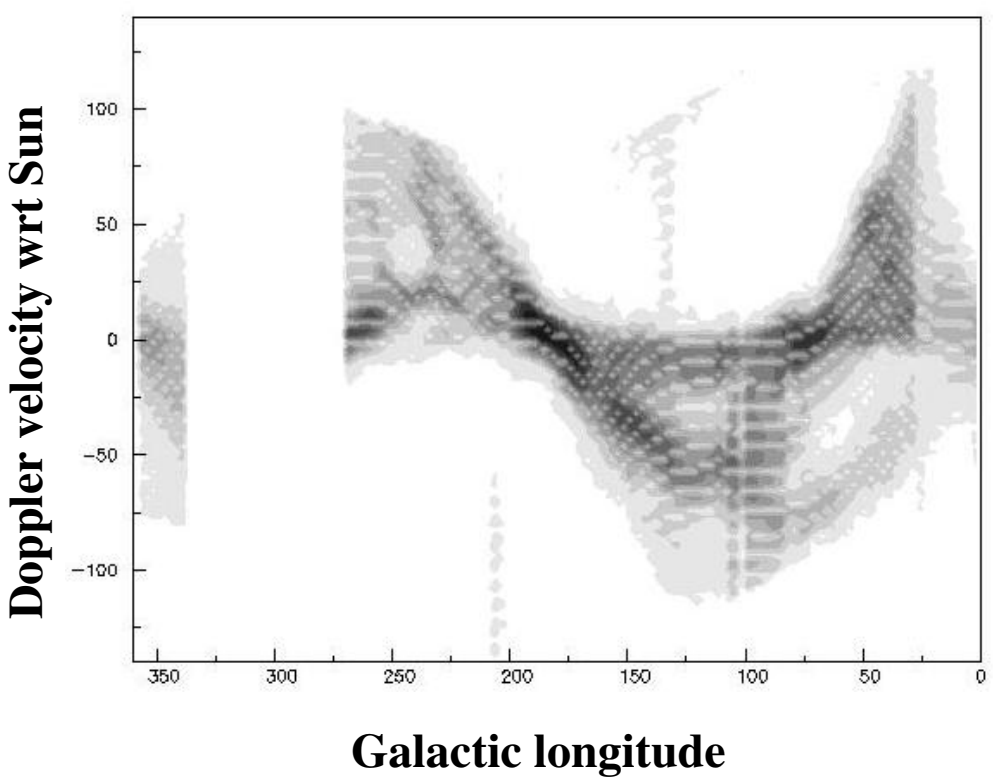
A

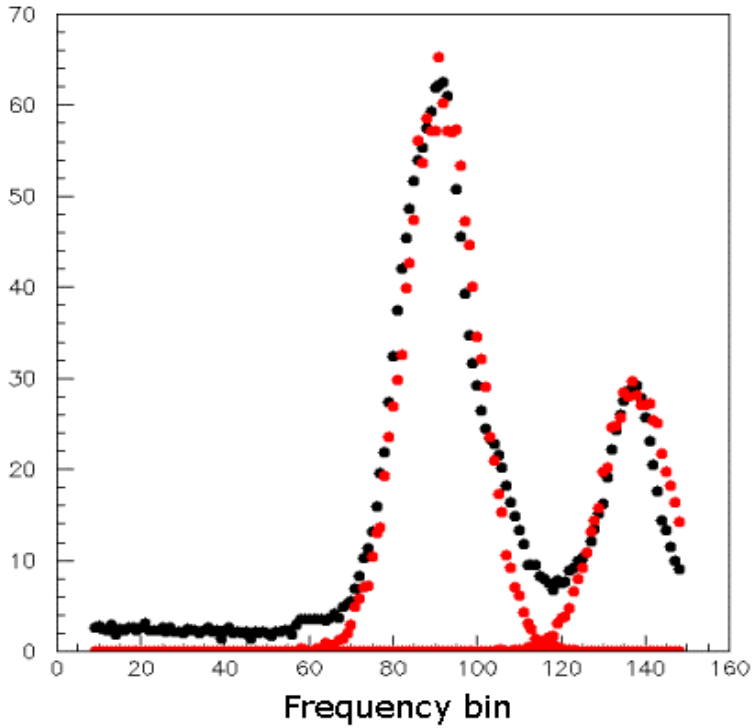


B

Velocity Doppler spectra have been collected along the disk of the Milky Way over three quarters of the galactic longitude. They show evidence for differential rotation.

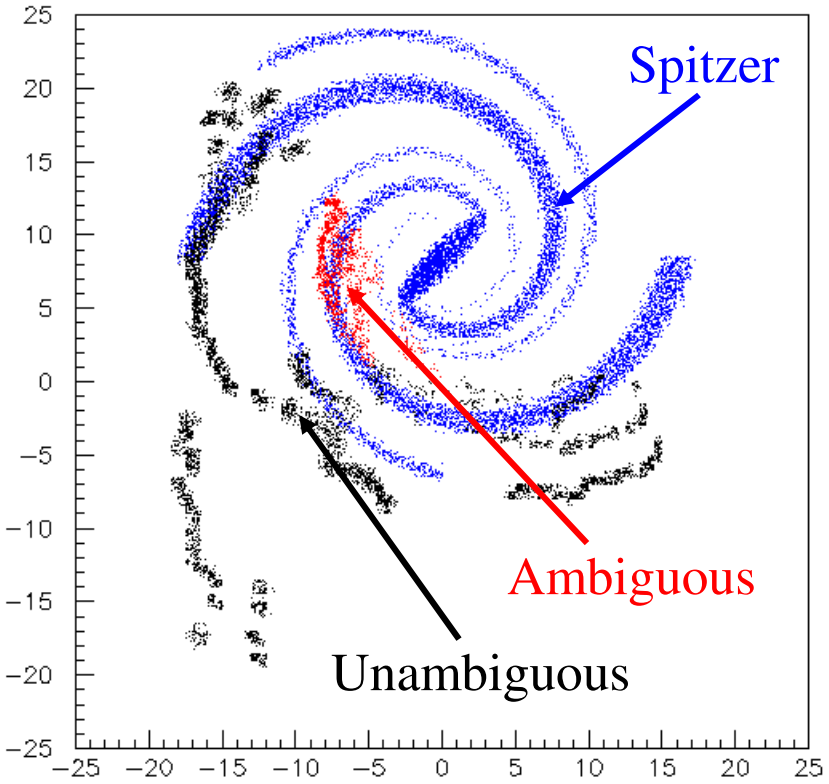
Each spectrum has been reduced into peaks associated with different clouds of atomic hydrogen.



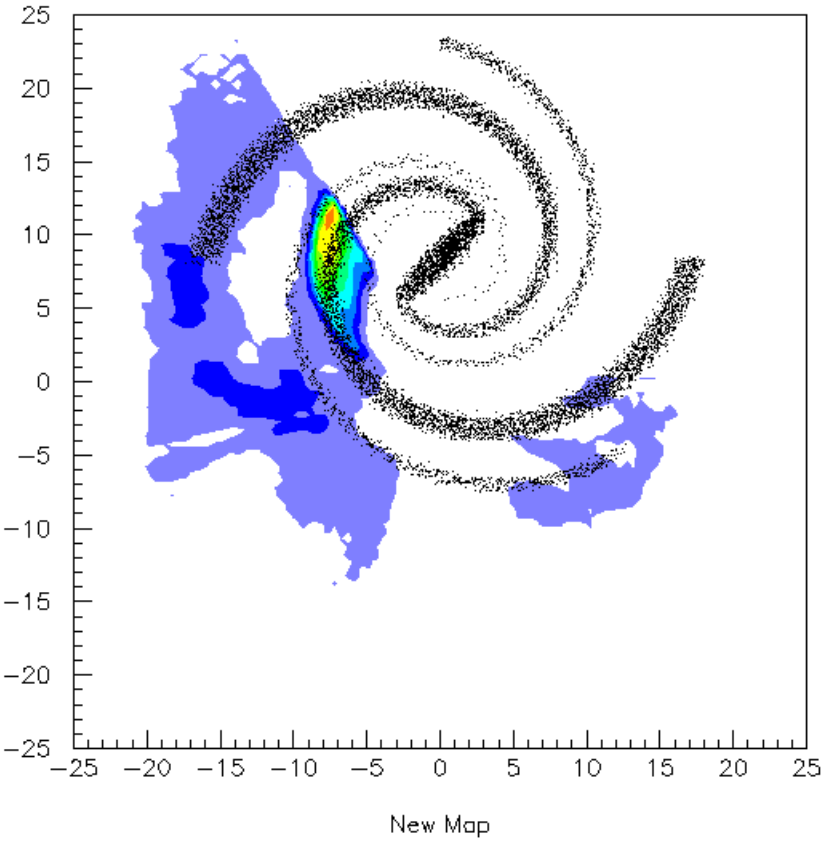


A map of atomic hydrogen in the Milky Way disk has been constructed and compared with the known arm and bar structure.

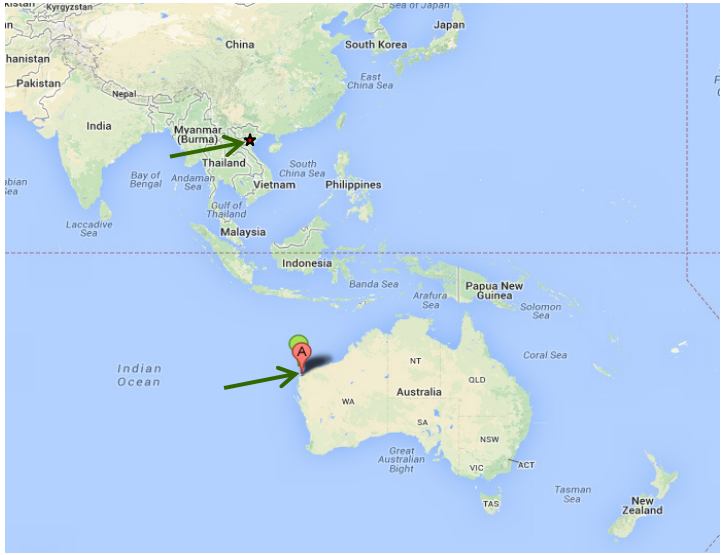
Peak positions

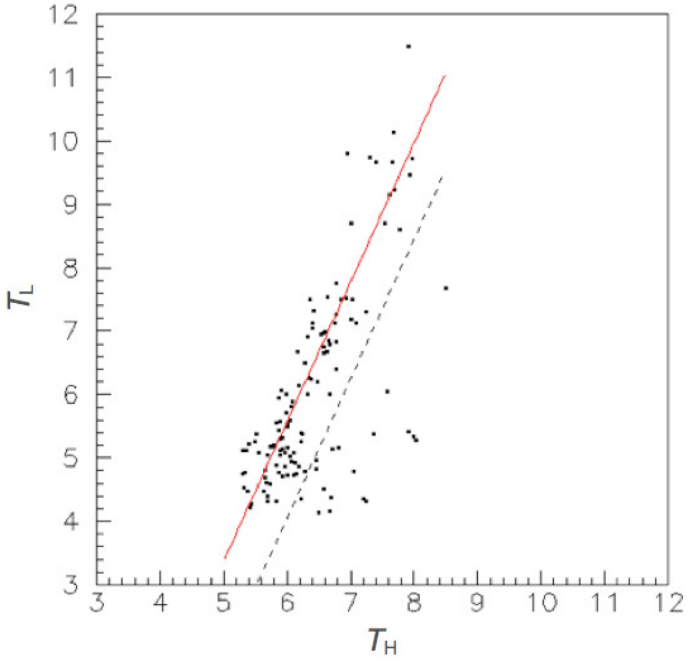


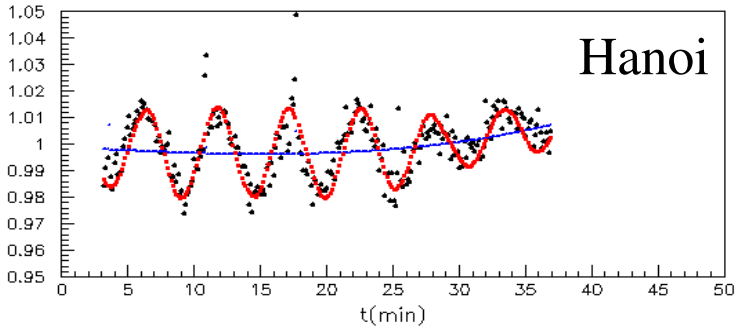
Map of power density

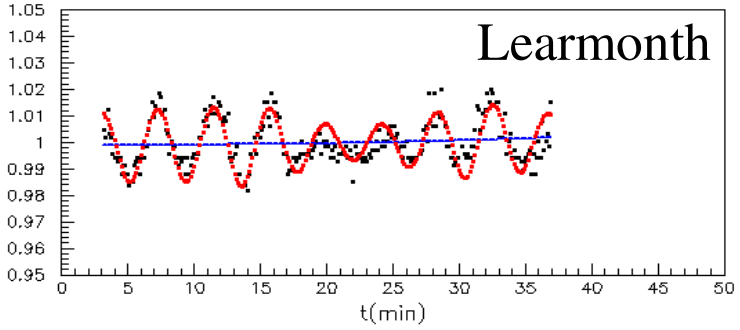


The Sun has been tracked for several months. A joint analysis of the collected data with similar data taken by the Learmonth Solar Observatory in Australia has shown the presence of flares and has given evidence for **mHz oscillations** at the percent level (*published in Solar Physics*):



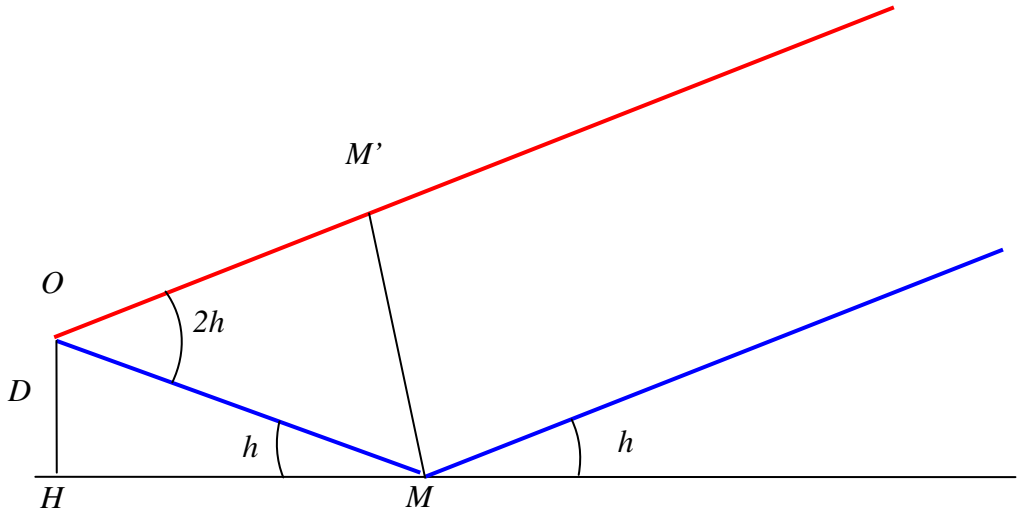






Strong correlation between Hanoi and Learmonth periods. $T_L = 2.2T_H - 7.6$ mn

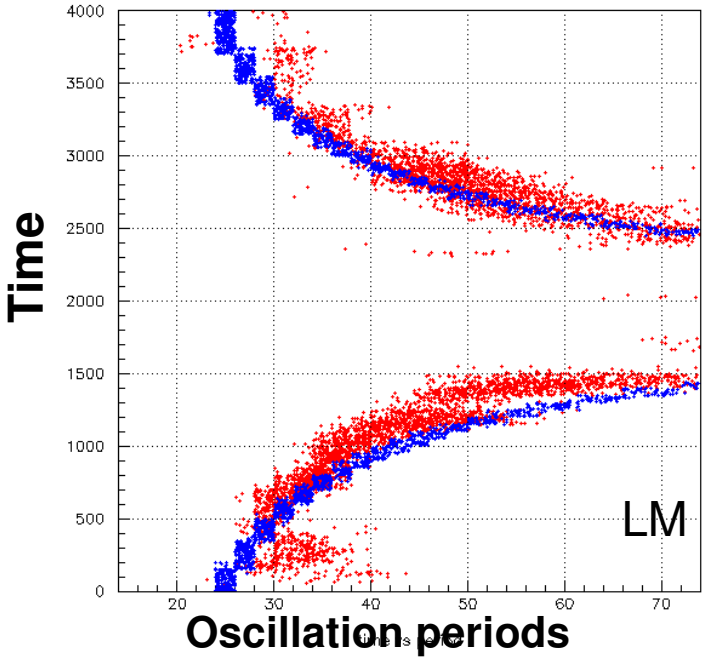
Interpretation of the oscillations

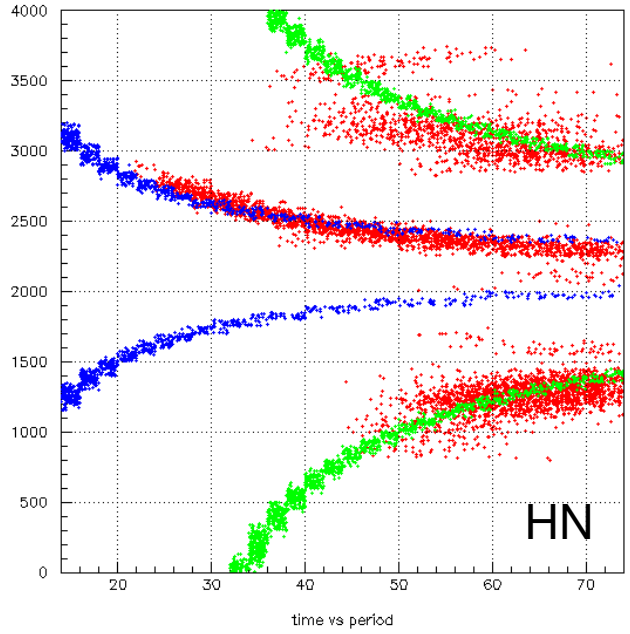


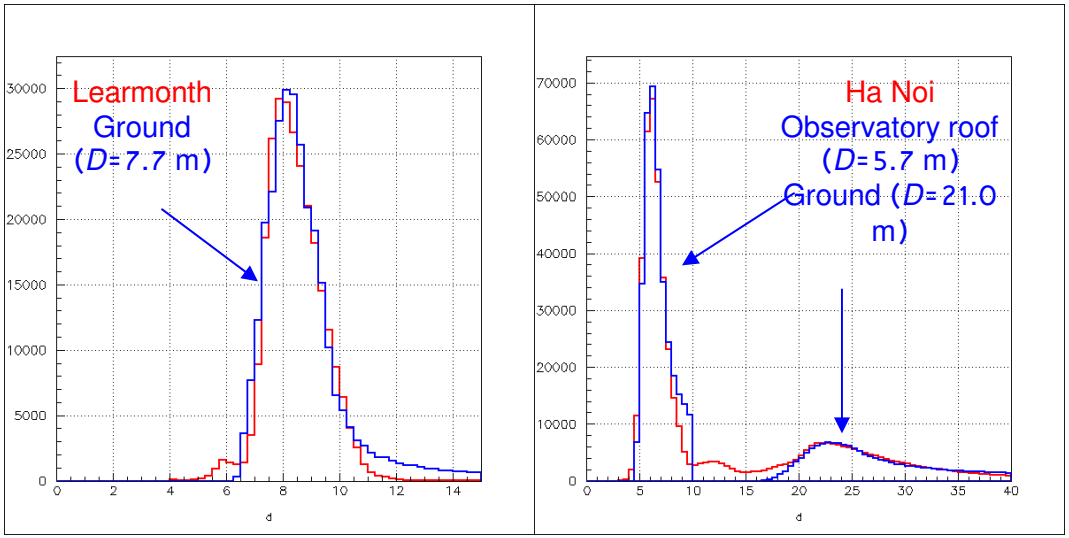
The intriguing existence of correlations between the Ha Noi and Learmonth observations had first been considered as an argument against a possible instrumental effect. It is now clearly established that the cause of the correlation is purely instrumental.

For now three months, a new campaign of observations and a refined method of analysis have shown that **simple specular reflection from ground gives a good description** of the observed oscillations and explains the correlations that had been previously observed.

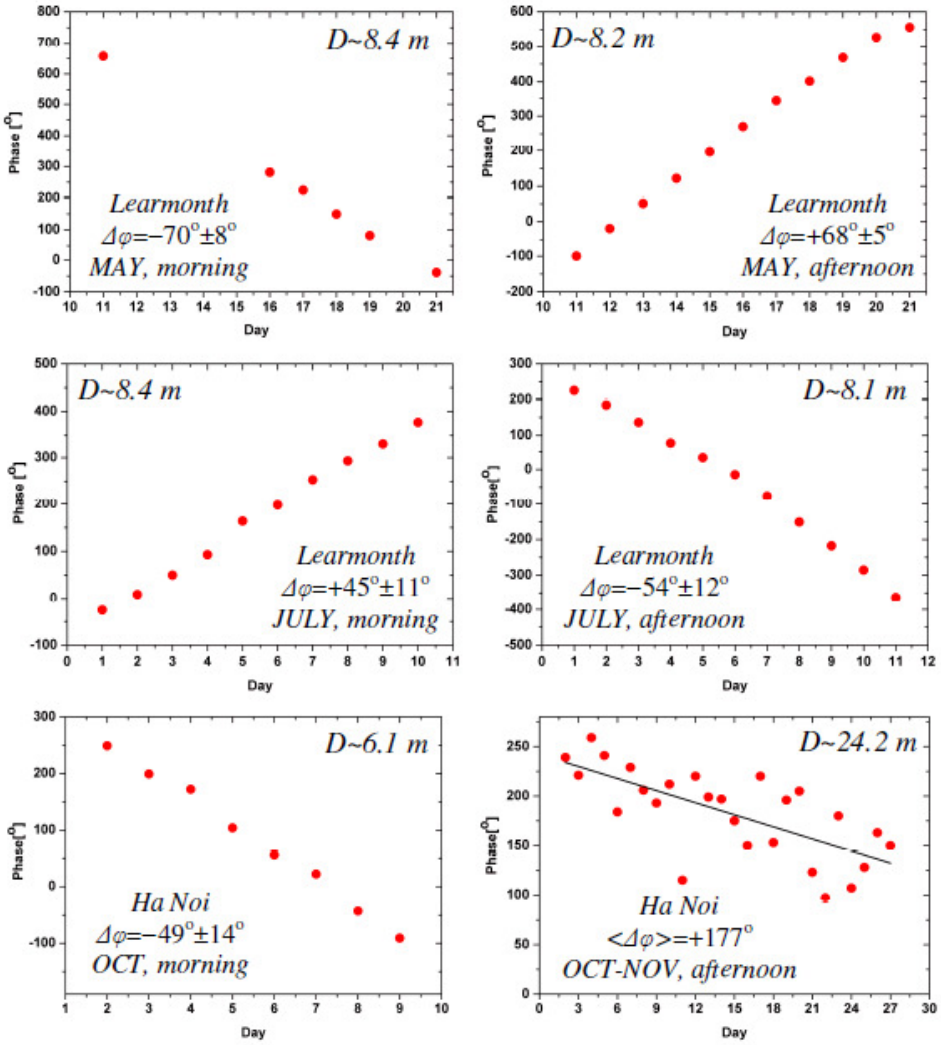
Interpretation of the oscillations

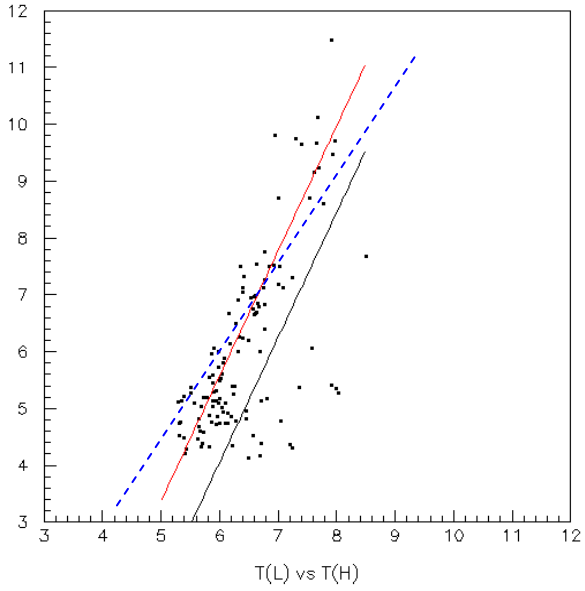


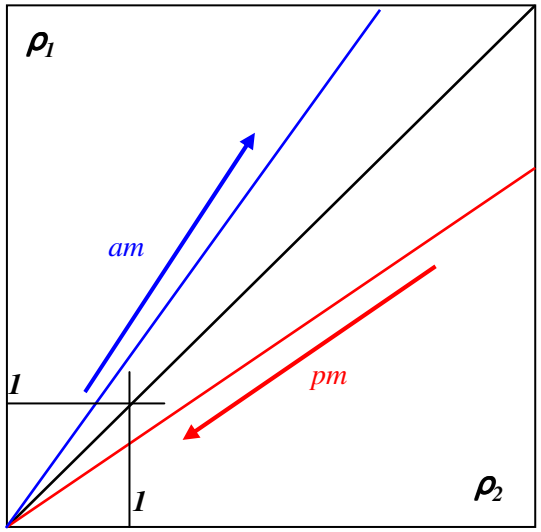




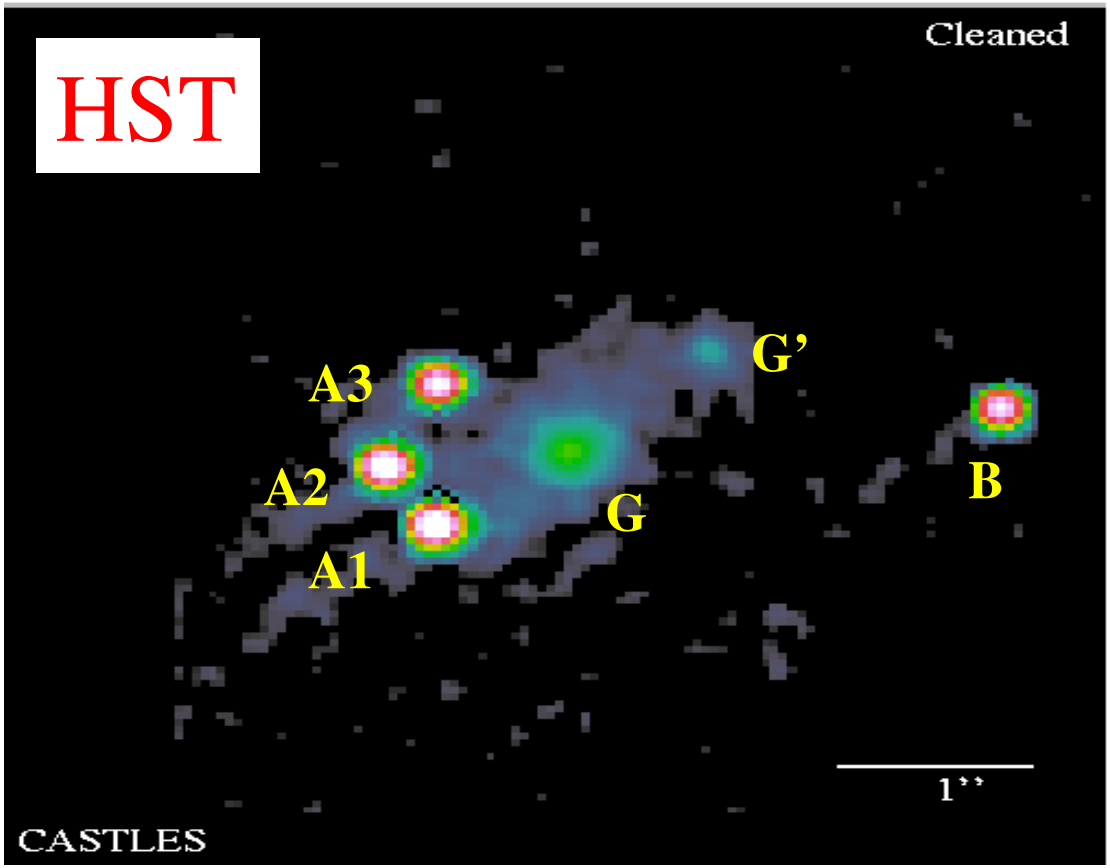
Interpretation of the oscillations



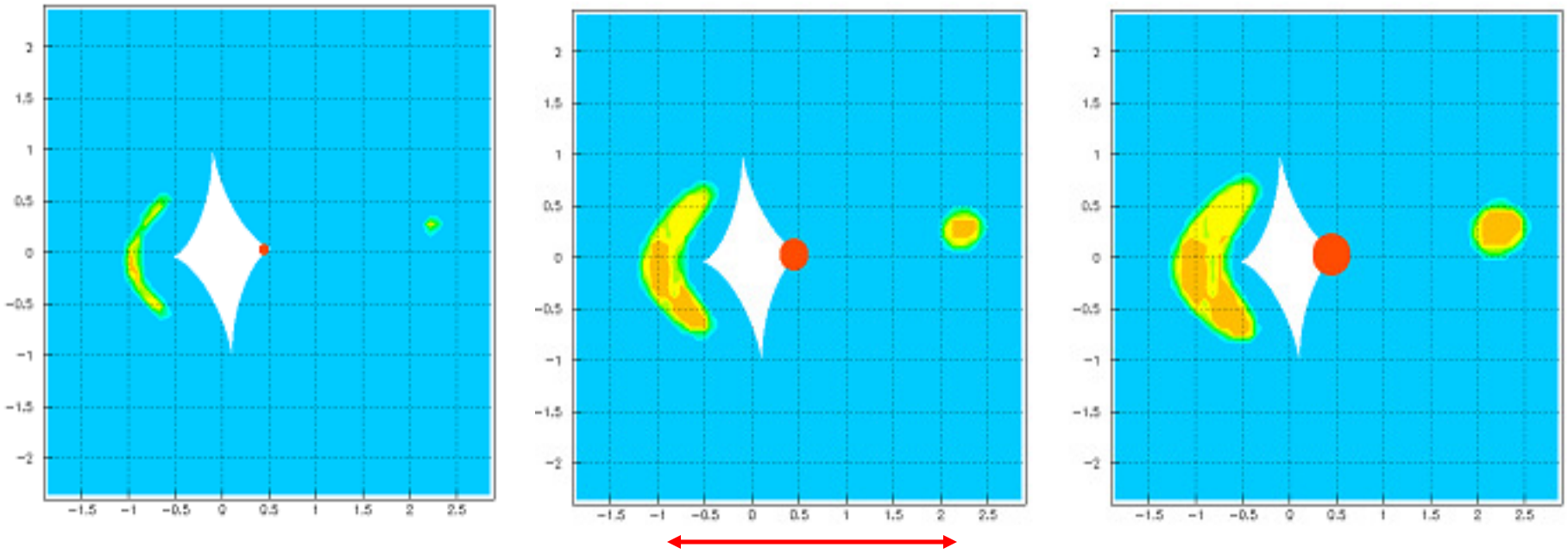




Under co-supervision of Dr Frederic Boone (IRAP, Toulouse) a student from VATLY studies the host galaxy of a gravitationally lensed high redshift quasar (z~2.8, look back 11.3 Gyr), RXJ0911. Detection of the CO(7-6) line measures its gas content and the continuum below its dust content, providing useful information on the star formation rate in such early galaxies.



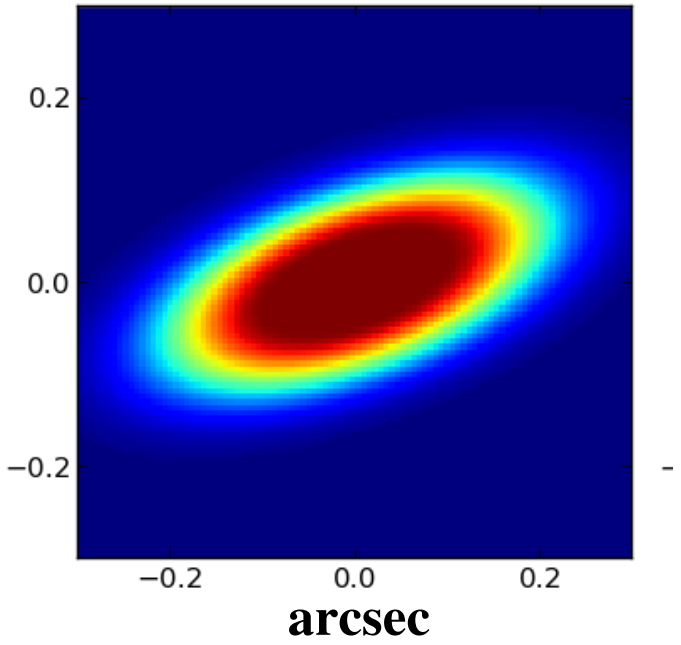
Lensing is complicated by the fact that the extended source overlaps the lens caustic. We studied this peculiar situation in detail (published in Research in Astronomy and Astrophysics)

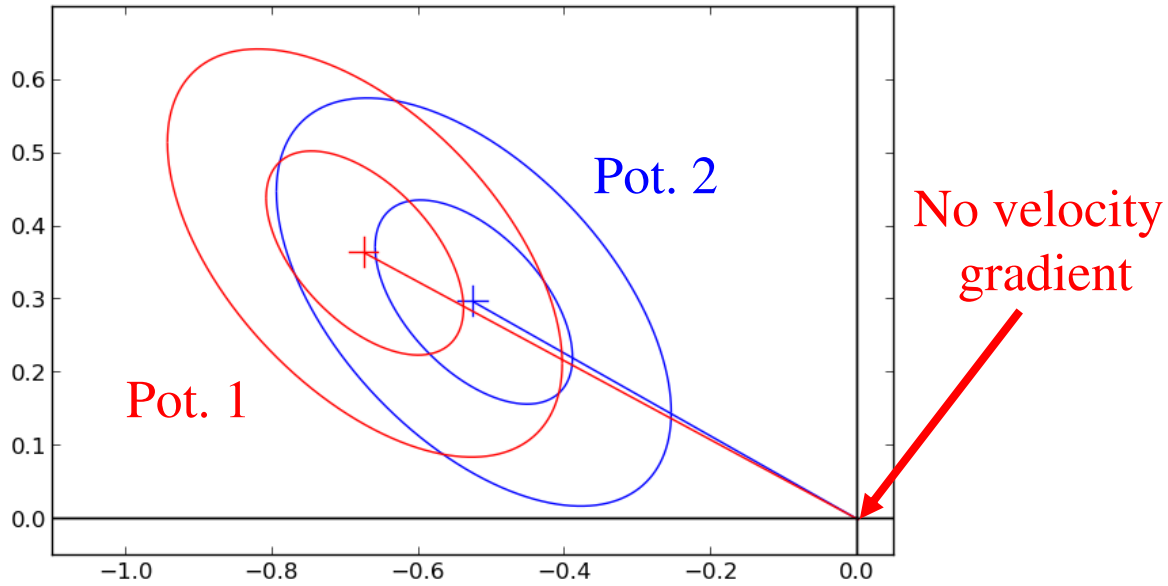


The results show that the source has a radius of 850±120 pc on the line (~7 s.d.) and 260±130 pc (only 2 s.d.) in the continuum.
They also provide evidence for ellipticity and for a significant velocity gradient (molecular outflow and/or rotation)
(Preliminary results published in Astronomy and Astrophysics Letters)

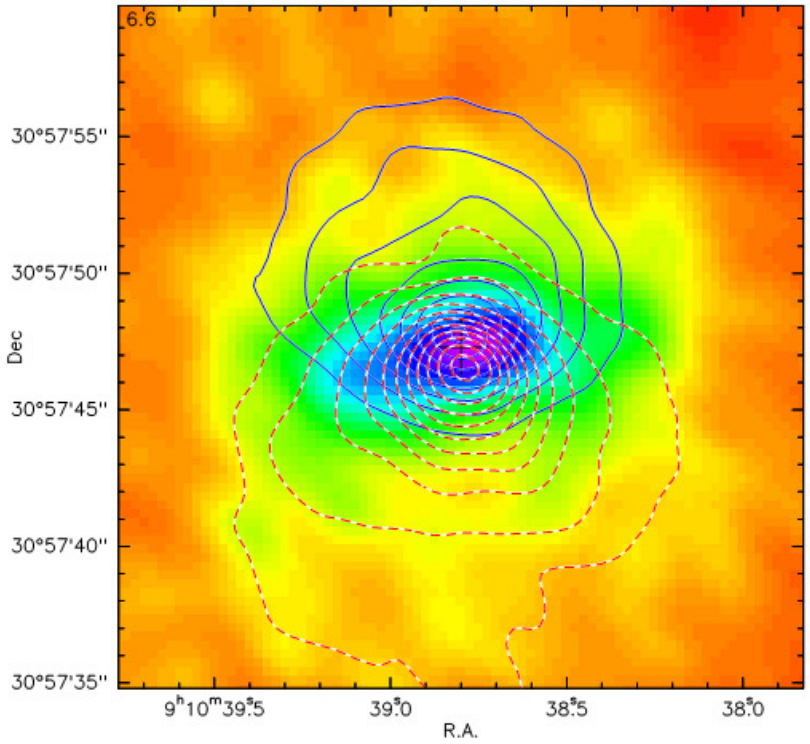
Ellipticity: 3.3 s.d. away from circular

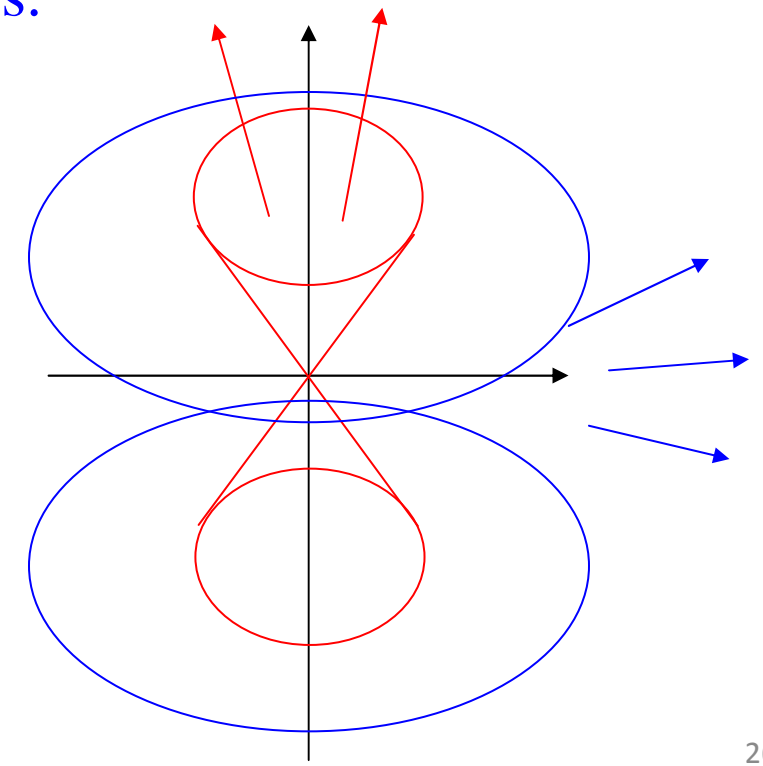
Evidence for velocity gradient at 4.5 s.d.

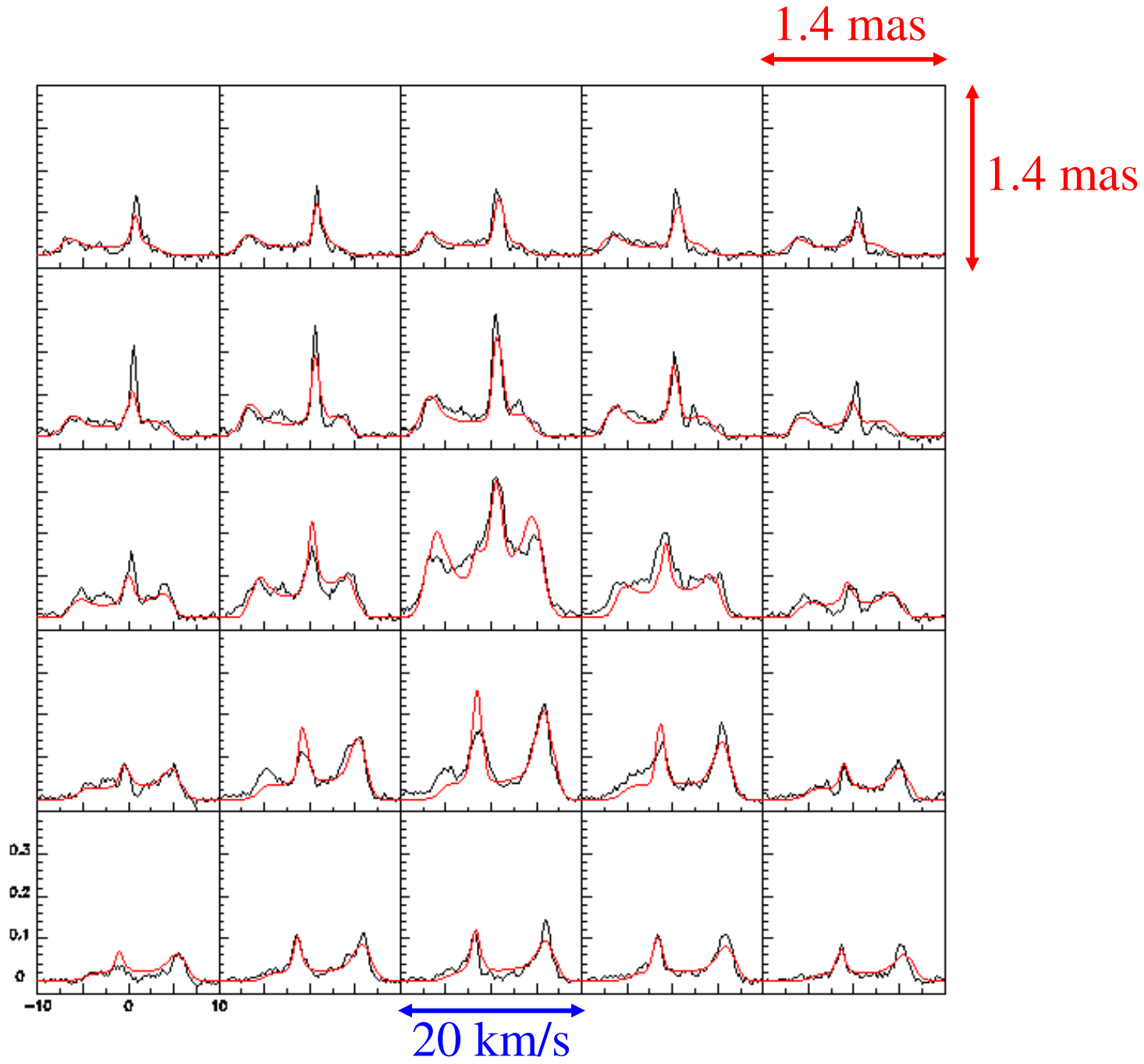




Under co-supervision of Dr Thibaut Le Bertre (LERMA, Paris) another student studies an AGB star in its thermal pulsing phase, RS Cnc, using high resolution PdBI data on the CO(1-0) and CO(2-1) lines and VLA data on HI. The star features a bipolar molecular outflow with a wind velocity of ~8 km/s, superimposed on a lower velocity wind (~2 km/s). Detailed studies of the velocity spectra allow for constructing a model of the star atmosphere accounting for many, but not all, of the observed features.






1.4 mas
1.4 mas
0.3
0.2
0.1
0
−10
0
10
20 km/s

TEACHING AND TRAINING

Astronomy and astrophysics are not included in Vietnam curriculum. Some astronomy and astrophysics are being taught under physics department.

At Hanoi National University of Education (NQ Lan, who does some theoretical astrophysics on dark matter and dark energy).

Our lab provides lab work to students from University of Science and Technology of Hanoi (USTH); Some introductory lectures on astronomy and astrophysics are given at Hanoi National University (PT Nhung, DV Trung), HNUE (myself and DV Trung); HCM University of Education (Cao Anh Tuan), HCM International University (PB Ngoc).

- Occasional summer schools/workshops are organized with financial support from IAU and Rencontres du Vietnam.
- We joined SEAAN, the South East Asia Astronomy Network and SEAYAC, the South East Asian Young Astronomers Collaboration.
- Last year, International Center for Interdisplinary Science & Education was established in Quy Nhon


Xth Rencontres du Vietnam
Exoplanetary Science
ICISE, Quy Nhon, April 20-26, 2014
Main Topics
Surveys and their impact
Exoplanetary atmospheres
Dynamics of planetary systems
The diversity of bulk compositions
Ground based and space instrumentation
What could be learnt in
the coming decade
International Programme Committee
L. Celnikier, France
J. Dumarchez, France
S. Ida, Japan
L. Kaltenegger, Germany
J. Laskar, France
D. Lin, USA
M. Mayor, Switzerland (Chair)
S. Mazevet, France
F. Pepe, Switzerland
G. Ricker, USA
D. Rouan, France
J. Trân Thanh Vân, France
http://vietnam.in2p3.fr/2014/exo/index.html
Photo Dào Tiên Dat

Vietnam Space Center Project

Vietnam National Satellite Center (VNSC): Research and development, technology application and development human resource in **satellite technology**; receive, manage and implement Vietnam Space Center Project.

Vietnam Space Center Project: On 19/09/2012, the Ground Breaking Ceremony of Vietnam Space Center Project was successfully launched at Hoa Lac High-Tech Park, Hanoi (9ha).

The model of Vietnam Space Center

CONCLUSIONS

Astrophysics are not significantly supported in Vietnam and only a very few individuals do research in the field.

Progress implies making the science top deciders aware of the importance of encouraging and supporting teams as much as individuals, of making room for fundamental research at the frontier of knowledge, of spelling out a clear scientific research policy for the country.

There is still a long way to go but we hope for the future creation of a research institute that would favor the progress and development of such research.

In order to survive, we need to work in close collaboration with foreign colleagues.

Xin cảm ơn!

Thank you for your attention!