

# The CAAUL Gazette

The International Newsletter of the Centre for Astronomy and Astrophysics of the University of Lisbon

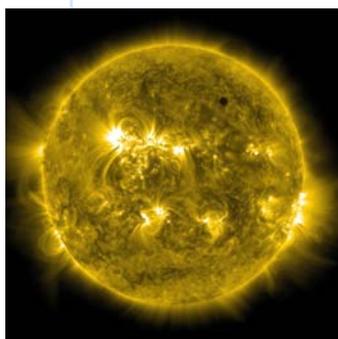


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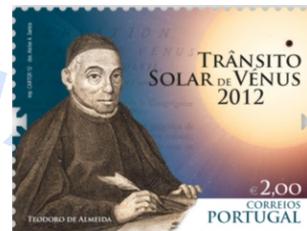
## Introduction

On 4th December, 1639, the English astronomer Jeremiah Horrocks observed, for the first time, the transit of Venus using a simple helioscope by focusing the image of the sun through a telescope onto a piece of paper. This simple observation allowed him to make estimations of not only the size of Venus, but also the astronomical unit (the distance between the Sun and the Earth) – a value important to establish the scale of the solar system. Since then, there have been only six other Venus transits – the most recent being in early June, this year. They have been studied by astronomers from the major observatories around the world, and not least by Portuguese astronomers - Father Teodoro de Almeida was one of four Portuguese astronomers to observe the transit of 1761. The intervening Venus transits have not provided such important results as those of Jeremiah Horrocks; however, the recent observations in June this year may help to establish important techniques for detecting extrasolar planets.

Recently, the Centre for Astronomy and Astrophysics of the University of Lisbon decided to initiate a newsletter – the CAAUL Gazette – dedicated to publicising the various events, outreach activities and research carried out by members of the Centre, and aimed at the international scientific



Ultra-high definition view of the 2012 Venus transit as seen from NASA's Solar Dynamics Observatory (NASA).



Portuguese stamp commemorating Father Teodoro de Almeida who observed the Venus transit of 1761 (CTT).

community. To inaugurate this newsletter, it was decided to coincide the first issue with the Venus transit. In fact, one of the research groups within the Centre has been leading the Portuguese contribution to an international effort to observe the Venus transit in June.

This newsletter will, furthermore, include some short non-specialist articles about astronomy and astrophysics. In particular, in the AstroConundrum section, we will invite established researchers to elaborate on a particular piece of intriguing astronomical or astrophysical research from the recent or distant past. In this first issue, Prof. Paulo Crawford considers who actually discovered the expanding Universe. In the RedShift section, we welcome proposals for articles which have an interesting take on recent astronomical or astrophysical research, science legislation, international collaboration/cooperation, changing attitudes towards astronomy and astrophysics... and can be presented as a straightforward article, comment or even a short story. In this issue, it is a short story based around the Venus transit of 2117.

We very much hope that this first issue of the CAAUL Gazette will be the start of a regular publication of the Centre and that there will be a special edition of the Gazette in 2117 - the year of the next Venus transit – to celebrate its 105 years of existence!

**David Berry, General Editor**

## Director's Comment

Welcome! This is the first edition of the Centre for Astronomy and Astrophysics of the University of Lisbon's International Newsletter, the CAAUL's Gazette. With it we aim to strengthen the link to our collaborators and prospective researchers and students, bringing them a better knowledge of our activities. Each quarterly issue will include groundbreaking results from our research, news about recent arrivals and departures, outreach activities and even historical notes prompted by CAAUL's beautiful host, the Astronomical Observatory of Lisbon. By making it very focused we hope this can become a way to quickly provide an overview of what is happening at CAAUL, and pass along some of the excellent work developed

here, by the groups of "Planetary Atmospheres", "Star Formation and Interstellar Medium", "Galaxy Formation and Evolution", "Cosmology" and "Optical Instrumentation for Astrophysics".

We live in wonderful times for the study of the Universe, with an astounding range of new instruments and telescopes starting operations and bringing us closer to the understanding of what surrounds us. It is a true challenge to take full advantage of these new capabilities. But it is one that CAAUL is glad to take. We trust some of that excitement and motivation will be presented in these pages...

**José Afonso, Director of CAAUL**

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This newsletter is available at

<http://www.caaul.oal.ul.pt/gazette>

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[www.twitter.com/caaul\\_astro](http://www.twitter.com/caaul_astro)

## Upcoming Events

CAAUL's activity is present in major scientific events throughout the world. This section will keep you informed about up and coming events that CAAUL organizes or participates in. You will find here notices of national and international conferences with the presence of CAAUL's researchers as well as major outreach events, often organized by the Astronomical Observatory of Lisbon and with the support of CAAUL. Relevant funding opportunities, when available, will also be advertised here.

### Conferences:

24 July to 2 August 2012:

**Summer School Alpbach 2012: "Exploration of the Giant Planets and their Systems", Alpbach/Tyrol, Austria**

10 September to 23 September 2012:

**Growing-up at high redshift: from proto-clusters to galaxy clusters, Villanueva de la Cañada, Madrid, Spain**

23 September to 25 September 2012:

**XXII ENAA - National Meeting of Astronomy and Astrophysics, Porto**

23 September to 28 September 2012:

**EPSC - European Planetary Science Congress 2012, Madrid, Spain**

### Outreach:

20 July to 14 September 2012:

**Living Science - Ciência Viva**

Every Friday during this summer, the Astronomical Observatory of Lisbon will collaborate with the national agency "Ciência Viva" promoting several activities like sun and night sky observations with telescopes and a guided tour to the historical main building of the Observatory, with the participation of CAAUL's researchers.

Every last Saturday of the month:

**Nights at the Observatory**

This public outreach activity takes place at the Astronomical Observatory of Lisbon. In each session there will be a guided tour to the historical main building of the Observatory, a public talk, usually given by a CAAUL researcher, and guided observations of the night sky.

For more information contact:  
**João Retrê**

## News from CAAUL

### Researcher from CAAUL Receives Honourable Mention from Gravity Research Foundation

Francisco S. N. Lobo, researcher from the Centre for Astronomy and Astrophysics of the University of Lisbon (CAAUL), received an Honorable Mention from the Gravity Research Foundation for the article "Generalized Dark Gravity" by Tiberiu Harko and Francisco S. N. Lobo. This is an annual contest dedicated to the

subject of gravitation with a huge participation worldwide, with five prizes awarded for the best essays, and a handful of honourable mentions. Among some of the previous winners are Stephen Hawking and several Nobel Prize winners, including George F. Smoot.

**João Retrê**

### Researcher from CAAUL Receives Outstanding PhD Award from the University of the Basque Country

On the 18th May 2012, Javier Peralta, researcher at CAAUL, was given the "Outstanding PhD Award," for his thesis entitled "Winds, Waves and Turbulence in the Clouds of Venus". This prize is awarded by the University of the Basque Country, Spain, to the theses with the highest international impact after two years of its publication.



**João Retrê**

Planetary scientists of the University of the Basque Country - Javier Peralta is third from right.

### Observations of the Atmosphere of Venus During the 2012 Transit

This year we have witnessed a major astronomical event. The passing of Venus across the solar disk, one of those rare phenomena that in the past have stirred up the imagination and led to scientific expeditions to the 4 corners of the world. Indeed, in June 6, 2012 we have witnessed the last Venus transit of the 21st century and, like in past centuries, astronomers came up with new ways of looking at Earth's evil twin planet, Venus.

For example, Paolo Tanga and Thomas Widemann, of the Nice and Paris Observatories set up the innovative Venus Twilight Experiment (<https://venustex.oca.eu/foswiki/>): seasoned observers would take a set of 9 custom-built coronagraphs (four-inch portable refractor telescopes equipped with cameras and solar occulting masks), called Cytherographs, to such places as Australia, Kazakhstan or Hawaii,

where the transit was visible partly or in its totality.

The objective has been to do photometric studies of the faint halo of light which appears on the rim of the Venus disk at ingress or egress, and which allows measuring the temperature and density just above the top of the Venus cloud layer. The mesosphere of Venus is still poorly known and this region cannot be easily sounded by orbiters such as Venus express. This is why it is so important to coordinate complementary space and ground-based observations.

CAAUL participated in this experiment and João Retrê and Pedro Machado travelled to India to observe egress at the Udaipur Solar Observatory with Prof. Ashok Ambastha. Under burning temperatures of 45°C (the hottest of the nine observing sites) they caught a glimpse of the fleeting halo through a turbulent atmosphere with their 610-nm red filter.

Data from this successful mission will be partly analyzed by CAAUL's team and compared with coordinated Venus Express data and with past ground-based observations made at the VLT and at the Canada France Hawaii telescope.

Understanding Venus and its runaway greenhouse effect is key to understanding the Earth's evolution, its place in the planetary panoply, and perhaps help the weather forecast for when the next transit happens - in 2117!

**David Luz**



João Retrê and Pedro Machado on their way to Udaipur Solar Observatory, India.

## Arrivals and Departures

**Ruth Grützbauch** recently started a FCT post-doctoral fellowship at CAAUL. Her research is focused on galaxy formation and evolution and the influence of galaxy environment on shaping the galaxies we observe today and in the early Universe. She did her PhD at the University of Vienna and spent the following 3 years as a research fellow at the University of Nottingham. After enjoying the English weather for a while she is now very happy to be living in the beautiful city of Lisbon. "I really appreciate the motivating and cordial environment at the Observatory and am looking forward to lots of fruitful collaborations with members of the CAAUL."

**Ketron Mitchell-Wynne** graduated from the University of California Irvine and subsequently worked there for an additional one and a half years. He studied the properties of sub-millimeter galaxies using data from the SPIRE instrument onboard the Herschel observatory, and assisted in the reduction of data from the imagers onboard the Cosmic Infrared Background Experiment (CIBER) – a sounding rocket experiment designed to measure the extragalactic infrared background light. During his stay in Lisbon, where he is doing his PhD, Ketron hopes to study the high redshift universe and how giant radio galaxies are born.

## Recent Publications

- ◆ Peralta, J., Luz, D., Berry, D. L., Tsang, C. C. C., Sánchez-Lavega, A., Hueso, R., Piccioni, G., Drossart, P., "Solar Migrating Atmospheric Tides in the Winds of the Polar Region of Venus", 2012, *Icarus*, accepted (DOI: 10.1016/j.icarus.2012.06.015).
- ◆ Hueso, R., Peralta, J., Sánchez-Lavega, A., "Assessing the long-term variability of Venus winds at cloud level from VIRTIS-Venus Express", 2012, *Icarus*, 217, 585.
- ◆ Grützbauch, R., Bauer, A. E., Jørgensen, I., Varela, J., "Suppression of star formation in the central 200 kpc of a  $z = 1.4$  galaxy cluster", 2012, *Monthly Notices of the Royal Astronomical Society*, accepted (arXiv:1204.4417).
- ◆ Georgakakis, A., Grossi, M., Afonso, J., Hopkins, A., "The radio spectra of reddened Two Micron All Sky Survey quasi-stellar objects: evidence for young radio jets", 2012, *Monthly Notices of the Royal Astronomical Society*, 421, 2223.
- ◆ Farrah, D., Urrutia, T., Lacy, M., Efstathiou, A., Afonso, J., Coppin, K., Hall, P. B., Lonsdale, C., Jarrett, T., Bridge, C., Borys, C., Petty, S., "Direct Evidence for Termination of Obscured Star Formation by Radiatively Driven Outflows in FeLoBAL QSOs", 2012, *Astrophysical Journal*, 745, 178.
- ◆ Mauduit, J.-C.; et al., "The Spitzer Extragalactic Representative Volume Survey (SERVS): survey definition and goals", 2012, *Publications of the Astronomical Society of the Pacific*, in press ( arXiv:1206.4060).
- ◆ Corbelli, E., et al., "The Herschel Virgo Cluster Survey. X. The relationship between cold dust and molecular gas content in Virgo spirals", 2012, *Astronomy and Astrophysics*, 542, A32.
- ◆ Davies, J.I., et al., "The Herschel Virgo Cluster Survey - VIII. The Bright Galaxy Sample", 2012, *Monthly Notices of the Royal Astronomical Society*, 419, 3505.
- ◆ Cabral, A., et al. "ESPRESSO: design and analysis of a Coudé-train for a stable and efficient simultaneous optical feeding from the four VLT unit telescopes", 2012, paper accepted for the conference SPIE Astronomical Telescopes + Instrumentation (1 to 6 July 2012, Amsterdam).

## AstroConundrum

### The Expansion of the Universe:

#### Who Discovered the Expanding Universe? What was Really Discovered?

The detection of the expansion of the Universe is one of most important scientific discoveries of the 20th century. Indeed, it may be the most important fact we ever discovered about our origins. Until the identification of the cosmic microwave background, modern cosmology is principally founded on this discovery, which operated as cosmology's main observational basis. It is still widely believed that in 1929 Edwin Hubble discovered the expanding Universe (Hubble 1929). However, several authors have pointed out some misconceptions about the Big Bang and the meaning of the expansion of the universe. For example, in a recent paper *Grøn & Elgarøy (2007)* tell us: "Although more than 75 years have passed since Hubble's discovery of the expanding universe, there is still some confusion about how the expansion is to be interpreted."

*Kragh & Smith (2003)* have looked into this subject and they find that not until the 1950's did the notion of 'Hubble's law' and 'Hubble as the astronomer who has discovered the expanding universe' become common in the scientific literature. But they advise that the purpose of their paper "is not primarily to discredit Hubble, or to discuss priorities, but rather to problematize the entire notion of a discovery of the expanding universe." In any case, they argue that Hubble cannot reasonably be credited with the discovery of the expanding universe. Quoting *Stephen Brush (2001)*, which they consider to have produced a much more sensible evaluation: "One may say that Hubble 'discovered the expanding universe' in the same sense that Max Planck 'discovered the quantum': he established an empirical formula that seemed to imply and indeed led others to adopt it (and later to assume that he must have adopted it himself) – yet he drew back from explicitly advocating it as a true statement about the world, and on some occasions even suggested that it was false."

Recently, with the publication of the two books *Nussbaumer & Bieri (2009)*, *Bartusiak (2010)*, some more doubts have been cast on Hubble's

priority on the expanding of the universe discovery. Also, in a recent paper by *Luminet (2011)* one finds this very clear statement about the priority issue, which also clarifies the expansion of the universe as the recession of the galaxies: "The great novelty was that Lemaître provided the first interpretation of cosmological redshifts in terms of space expansion, instead of a real motion of galaxies: space was constantly expanding and consequently increased the apparent separations between galaxies."

*A. Friedmann (1922)* was the first to publish non-static solutions to Einstein's field equations of general relativity. However, he did not connect this result to astronomical observations. Five years later, the fundamental work of *Georges Lemaître (1927)*, "Un univers homogène de masse constante et de rayon croissant, rendant compte de la vitesse radiale des nébuleuses extragalactiques", was published in a local Belgian journal, and remained unnoticed by the broad scientific public until *Eddington*, working on the problem of instability of Einstein's static model, came across the Lemaître paper, and found in it the solution of its own problem. More important than that, in the same publication in which Lemaître reported his dynamical solution, he extracted the linear relationship between recessional velocity  $v$  and distance  $d$ :  $v=Hd$ . Combining the radial velocities of 42 extragalactic nebulae tabulated in *Strömberg* in 1925 (who relied mostly on redshifts from *Vesto Slipher (1917)*) and Hubble's distances from magnitudes (Hubble 1926), he calculated the rate of expansion of the Universe and obtained 625 km/s/Mpc or 575 km/s/Mpc, depending on how the data is grouped (compared to Hubble's 500 km/s/Mpc in 1929). That is, Lemaître connected his solution to astronomical observations.

Before fundamental works of *Friedmann* and *Lemaître*, two cosmological models were known: Einstein's original model (1917) containing homogeneously distributed dust-like matter, and *de Sitter's* model (1917) containing no matter. At the time, both models were believed to be static! It

was Lemaître, in 1925, who has discovered the stationary nature of the de Sitter solution, by introducing suitable coordinates. After the work on the new coordinates, Lemaître knew that the model looked for had to be non-stationary, with increasing radius. Wanting to have something between Einstein and de Sitter models, Lemaître adjusted constants of integration to their values in Einstein's static universe, and obtained a solution, known afterwards under the name of Eddington-Lemaître universe model. This solution describes the expanding universe with non-vanishing matter-density, and approaches asymptotically the static Einstein universe, as time goes to minus infinity.

This is a very concise report of the full story, which is much richer and more colourful than what can be shortened in a few pages. For those who

are interested, I recommend strongly the paper by Kragh and Smith, and the book by Nussbaumer and Bieri.

- Bartusiak, M. 2010, "The Day We Found the Universe", Vintage.  
 Brush, S. G. 2001, in "The age of the Earth: From 4004 BC to AD 2002", ed. by C.L.E. Lewis and S.J. Knell (London, 2001), 157-75, p. 62.  
 Grøn, Ø. and Elgarøy, Ø. 2007, A. J. Phys., Vol. 75, 151-157.  
 Heller, M. 1979, Lecture Notes in physics, no. 109, ed. by M. Demianski (Berlin, 1979), 199-210.  
 Hubble, E. 1929, Proceedings of the National Academy of Sciences of the United States of America, Vol. 15, Issue 3, p.168.  
 Kragh, H. and Smith, R.W. 2003, History of Science, Vol. 41, 141-162.  
 Lemaître, G. 1927, Annals de la Société Scientifique de Bruxelles, série A, vol. 47, p.49.  
 Luminet, J.P. 2011, Gen.Rel.Grav. vol. 43, 2911-2928.  
 Nussbaumer, H and Bieri, L. 2009, "Discovering the Expanding Universe", Cambridge Universe Press, Cambridge, UK.

**Paulo Crawford**

## RedShift

### Venusian Kiss

The Dean pondered the request for funding to resurrect the university's rusting astronomical observatory to measure the Venus transit in 2117. "Fundamental research indeed and a noble cause," he thought but the other proposal to demolish the observatory to make way for the new technology park could not be ignored. Sometimes he wished for the Wisdom of Solomon. Calls were made and two year funding was awarded to take the research through to just after the transit.

Champagne bottles were cracked open when the astronomers received their grant. All cynical opinions about the board's motivation were set aside and there was genuine belief in their research. "To assess the Earth's burgeoning greenhouse effect by analyzing sunlight through the atmosphere of the transiting Venus." A mouthful. Similar efforts had been made early last century to focus attention on the Earth's rampant rising temperatures. Other efforts even included personalities with names like 'Al' expounding on 'inconveniences'. But attention was short lived. What profit could be made from such studies anyway? It was the economy (stupid) that kept the country going. Research in engineering and technology and none of this fundamental science was the thing. It would be different this time around though – the Team-Leader was convinced. And his research was sure to bring him a Nobel.

At the television production centre, executives had for some time now been trying to find an angle to kick-start the new science series and this could be just the ticket. "What is this Venus transit anyway?" asked one. "Well, I think you see a black spot moving over the surface of the Sun." "And this is a major astronomical event?" "We'll make it one." The first television programme had a major Hollywood actor stepping out of his spaceship and walking on Venus's surface while explaining how the planet kisses the surface of the Sun just prior to the transit (the special effects were quite spectacular). "And this is key to understanding global warming," he added. Planetary science was truly becoming sexy. Teenagers marvelled at the good-looking actor, his brilliance and his quirky foreign accent. The astronomers cringed at the inaccuracies in his scientific descriptions and his Sagan-like side-parting hair-do, polar-neck jumper and corduroy jacket did not cut it with them either.

But the university was inundated with on-line enquiries about science courses, seconds after the closing credits. The Dean convened meetings to react to these enquiries and defunct undergraduate programmes were sought in the university basement. University admissions exploded with students wanting to "unlock the secrets of the universe." And even polar-neck jumpers and corduroy jackets became de rigueur. The fashion soon spread and other universities started to prize open their rusting observatories. Some claimed the Venus transit to be their very own and special titles were designated to observing the major astronomical event. In

Cambridge, it was 'Horrocks's Heritage' ("...after all, the first to observe it did study here"), in Moscow 'Lomonosov's Legacy' ("...after all, the first to observe the planet's atmosphere did study here"); in New York it was 'Venus's Transit' ("...after all, it was Venus's transit"); the fact that the planet's shadow, on this occasion, would not pass over these universities was neither here nor there.

A multitrillion-dollar film then became a sensation; apparently, hidden under the thick Venusian atmosphere was a portal for a truly intelligent species and our hero was to plug it before the crucial alignment (...or else "global warming really could be our undoing"). Hologram cinema tickets of the Venusian alien species were a must-have at schools and colleges. At the premier, centenarian astronomers were interviewed about Venus's last passionate celestial encounter in 2012. They reminisced about the night sky, seeing whole constellations and even the Milky Way. "And what of the transit?" "It was exciting stuff, and yes some did share our enthusiasm, but Bruce Willis was not there to save the day." ... "Bruce who?"

The big moment then arrived. The moment everyone had been waiting for. The Venus transit. The Team-Leader was there in his shiny resurrected observatory, his assistants and their instruments at the ready. At strategic points around the globe, excited teenagers gathered around reflectors and refractors as the sister planet approached the Sun's border (there was the promise of alien species appearing out of the planet's swirling clouds).

What observing eyes saw though was not a kiss, nor some warm celestial embrace, not even a perfunctory peck, more like a sneer and this all passed within minutes. Teenage disappointment was now palpable. "What is a major astronomical event, anyway?" became their refrain. No alien life forms appeared. And it was still hot the following day.

Emergency meetings were called for at schools and universities by concerned parents. "What good will ever come from studying the stars?" they demanded. Large corporations offered lucrative grants to tempt the very best science students back to the fold. A human resources manager laughed at the audacity of the science graduate even to consider applying. Prioritizing meant that funding for the astronomical research had to be "...regrettably, scaled back." As the Dean completed the deal to build the technology park, he wondered what would become of the shiny observatory building. A rising income for the University was on the cards though. "I can't help the rising temperatures, can I?"

In the observatory, the Venus transit had been deemed a resounding success. However, sallow faces stared at the monitors as initial analyses were made. It was all too late to stem the tide; a Venus climate was even closer than expected. "We can't do much about it now," the Team-Leader affirmed caustically. "But what the hell, we will get a paper in Nature".

**David Berry**

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