Hands-On Universe - Europe

EU-HOU

A VISION FOR ASTRONOMY/SCIENCE EDUCATION TO INSPIRE PUPILS

A MISSION TO REAWAKEN STUDENTS INTEREST FOR SCIENCE AND TECHNOLOGY

A NETWORK OF SCIENTISTS AND EDUCATORS WORKING TOGETHER

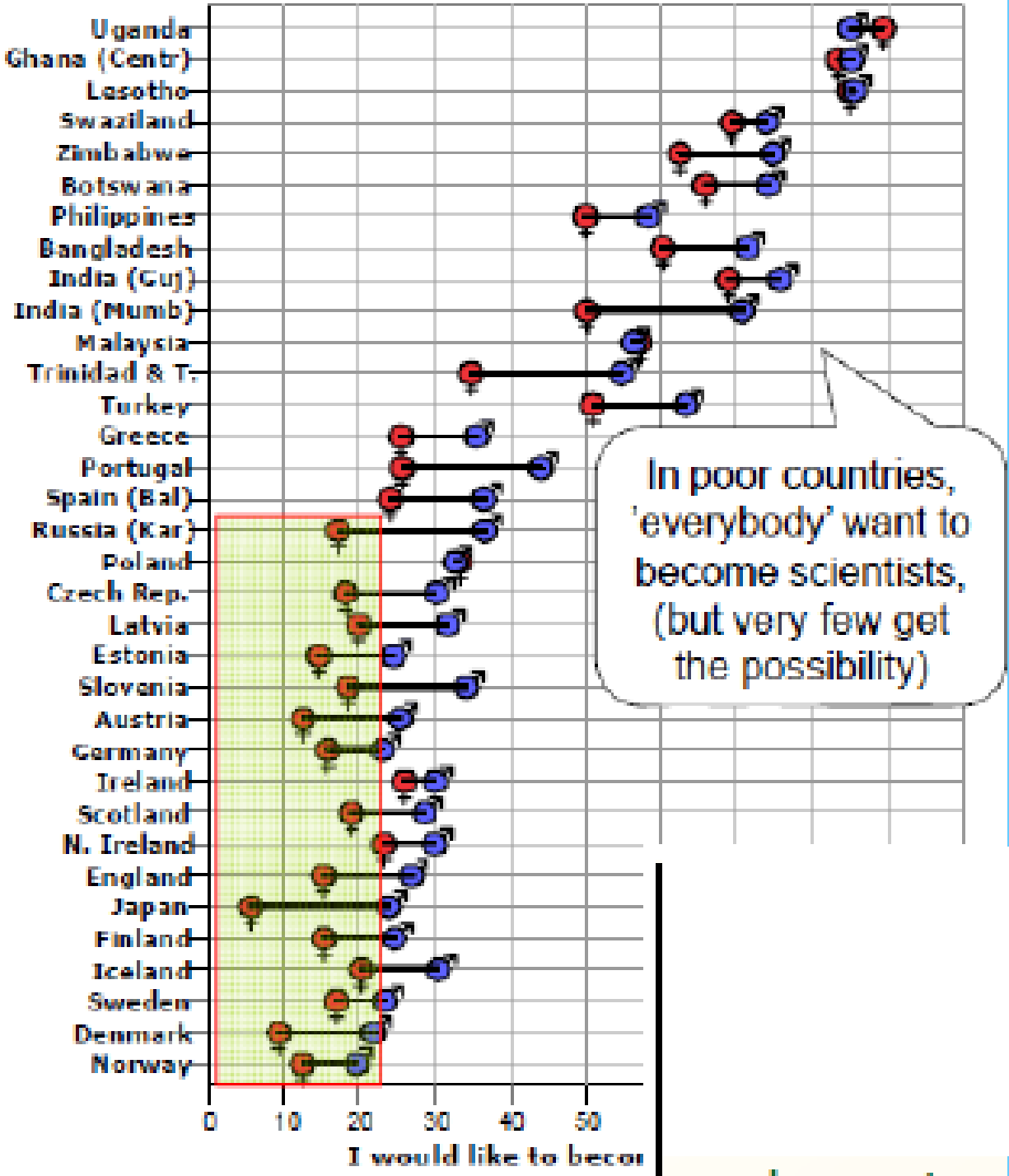
Roger FERLET

Institut d'astrophysique de Paris

Discover the cosmos – kick-off meeting – CERN – September 2011

I would like to become a scientist

In wealthy countries, very few want to become scientists – in particular not the girls



In poor countries, 'everybody' want to become scientists, (but very few get the possibility)

We've been teaching the same way for a long time...

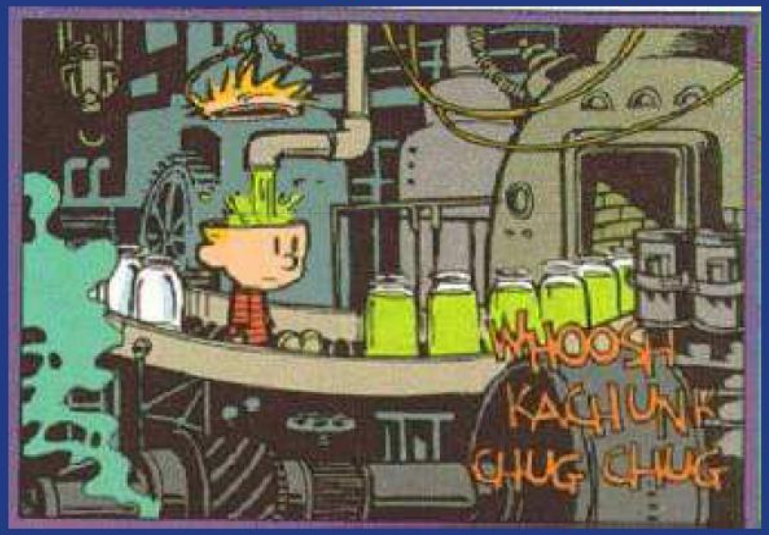
2000 years ago

Today

Research has been done on the effectiveness of our instruction

and the results show that lecture alone is not the most effective way to teach students basic concepts in science

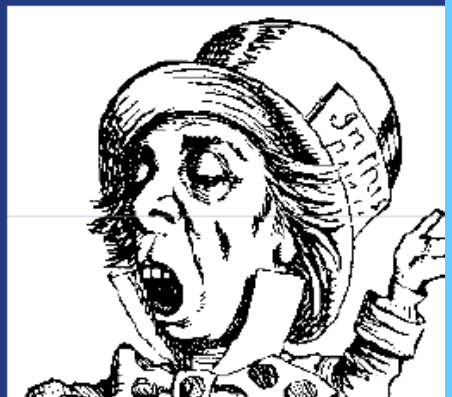
A Commonly Held Inaccurate Model of Teaching and Learning



Teaching by telling is surprisingly ineffective...

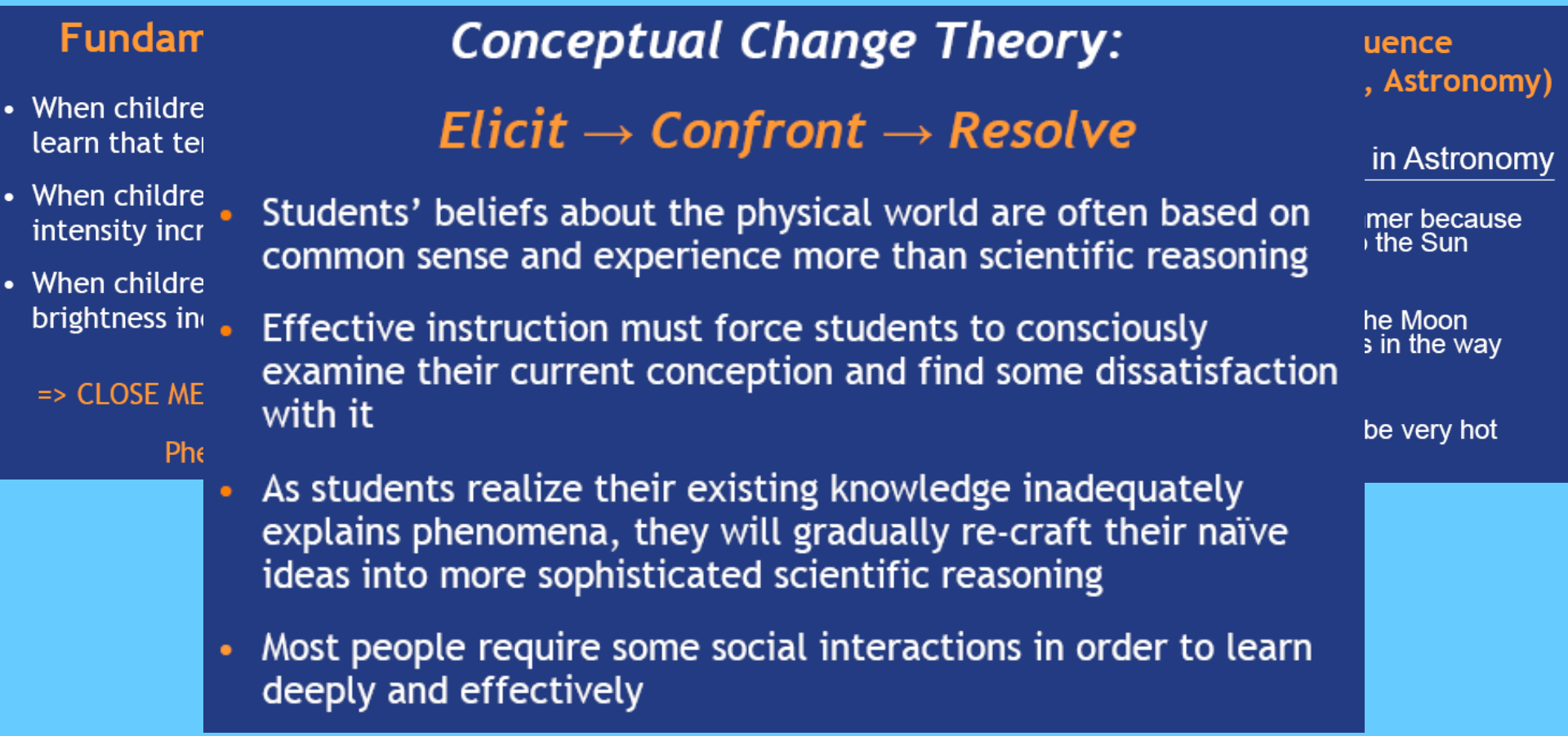
...if you want student to master concepts.

Minds must be *active* to learn



Students enter the lecture hall with *preconceptions* about how the world work.

If their initial understanding is not engaged, they may fail to grasp the new concepts that are taught, or they may learn them for the purpose of a test but *revert to their preconceptions* outside the classroom.



Science is a *human* and *collective* adventure, not a lonely and national activity

Comparing traditional lecture-based courses to courses incorporating interactive learning strategies

Full multivariate modeling of data from a study concerning several thousands of pupils, with 13 independent variables (12 demographic variables and interactivity) to explain one dependent variable: learning gain

Not surprisingly, a number of student characteristics (more years in college, more math and science background) led to higher gains.

Most importantly, the level of interactivity is the single most important variable in explaining the variation in gain, even after controlling for all other variables.

*Hestenes, Wells, & Swackhamer, "Force Concept Inventory," Phys. Teach. 30, 141-158 (1992)

Halloun, Hake, Mosca, & Hestenes, Force Concept Inventory (Revised, 1995) in Eric Mazur, *Peer Instruction: A User's Manual* (Prentice Hall. 1997)

*R. Hake, "Interactive-engagement vs traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses," Am. J. Phys. **66**, 64-74 (1998).

C. Crouch & E. Mazur, "Peer Instruction: Ten years of experience and results," Am. J. Phys. **69(9)**, 970-977 (2001).

A National Study Assessing the Teaching and Learning of Introductory Astronomy, Part I: The Effect of Interactive Instruction, Prather, E. E., Rudolph, A.L., Brissenden, G., & Schlingman, W.M., *American Journal of Physics*, 77(4), April 2009.

A National Study Assessing the Teaching and Learning of Introductory Astronomy, Part II: The Connection between Student Demographics and Learning, Rudolph, A. L., Prather, E. E., Brissenden, G., Consiglio, D., & Gonzaga, V., *Astronomy Education Review*, 9, 1, April 2010.

A mind is a fire to be kindled, not a vessel to be filled

Plutarch

It's not what the teacher does that matters; rather, it is what the students do

The fatal pedagogical error is to give answers to students who do not yet have questions

Hands-On Universe - Europe

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- ✓ **Stimulate** the excitement for science
- ✓ **Reverse** the « can't do » attitude to math and science
- ✓ Scientific **culture** → Literate citizens
- ✓ **Enquiry-based methods** - **promote** the scientific method
- ✓ Acquisition of **key skills**
- ✓ Development of **critical thinking**
- ✓ **Teachers** continuous professional **training**
- ✓ **Communicate** the intrinsic value and worth of research to a much broader audience
- ✓ Participate to the **modernisation** of EU schools – Foster scientific **vocations**

Science as an exciting learning activity
Bring actual research data into classrooms and get students actively involved in their learning:
learning science by doing science
(possibly opening the way for the students and teachers to contribute to astronomy)

HOW ?

- Use of *interactive* astronomy
  - # Possibility to observe with robotic telescopes, to acquire and process astronomical data
  - # Possibility to use data from the Virtual Observatory
- Use of *frontline* astronomy
  - # Resources developed in close collaboration between researchers and teachers to introduce research in classroom
  - # Use of real astronomical data within problem-solving experience close to modern research
- Resources ready to be used by teachers
  - # Flexible enough to allow teachers or pupils to go further
- Network to share educational tools, experience/ideas and support

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Bringing frontline interactive astronomy to the classroom

Université Pierre et Marie Curie (France) *E-HOU Coordinator*
Karl-Franzens-Universität Graz (Austria)
Observatoire royal de Belgique
Lykeio Agiou Nikolaou (Cyprus)
Astronomicky ustav Akademie (Ceske Republiky)
National Observatory of Athens (Greece)
Cork Institute of Technology (Ireland)
Fondazione IDIS – Citta Della Scienza (Italy)
Nicolaus Copernicus University (Poland)
Nucleo Interactivo de Astronomia (Portugal)
Universitatea din Craiova (Romania)
Universidad Complutense de Madrid (Spain)
House of Science (Sweden)
Cardiff University (United Kingdom)

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Hands-On Universe, Europe

Bringing frontline interactive astronomy to the classroom

Overall objectives

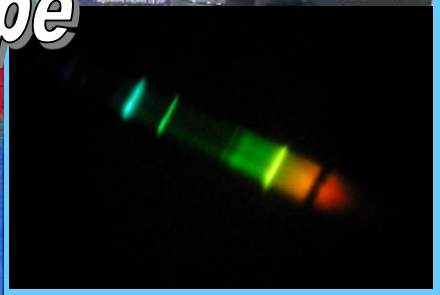
- Pedagogical use of worldwide telescope networks – optical and radio – operated remotely via Internet.
- Production of innovative pedagogical resources: exercises based on real astronomical data; trans-disciplinary in essence (astronomy, physics, mathematics, history, language...); available in English and in different European languages.
- Development of a users-friendly software: ***SalsaJ***
- Creation of a network of researchers and teachers for promotion of scientific and technological education; help to bring actual research data in classrooms.
- A specific web site with a free access multilingual portal to all available resources with means for sharing experience.
- Dissemination through workshops and teacher training sessions.

Observing tools :

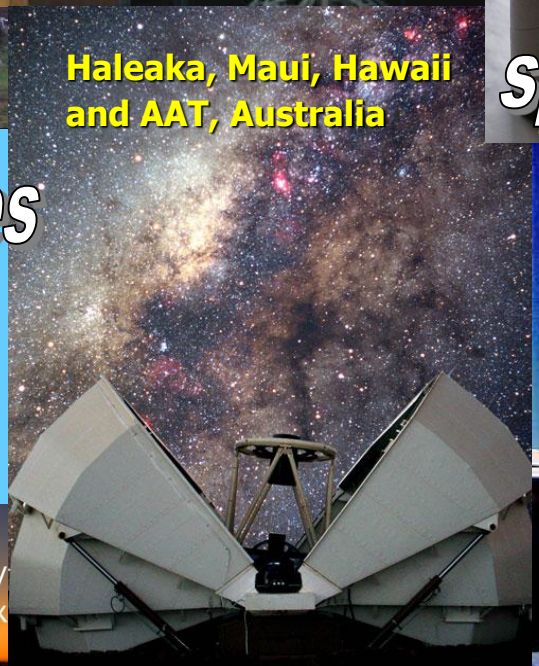
Radio Telescopes

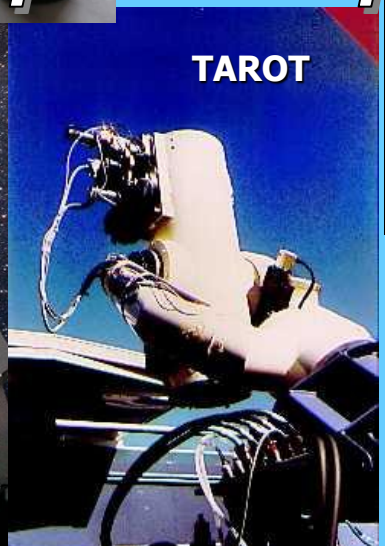
webcams

spectroscope



Optical Telescopes





Pedagogical resources :

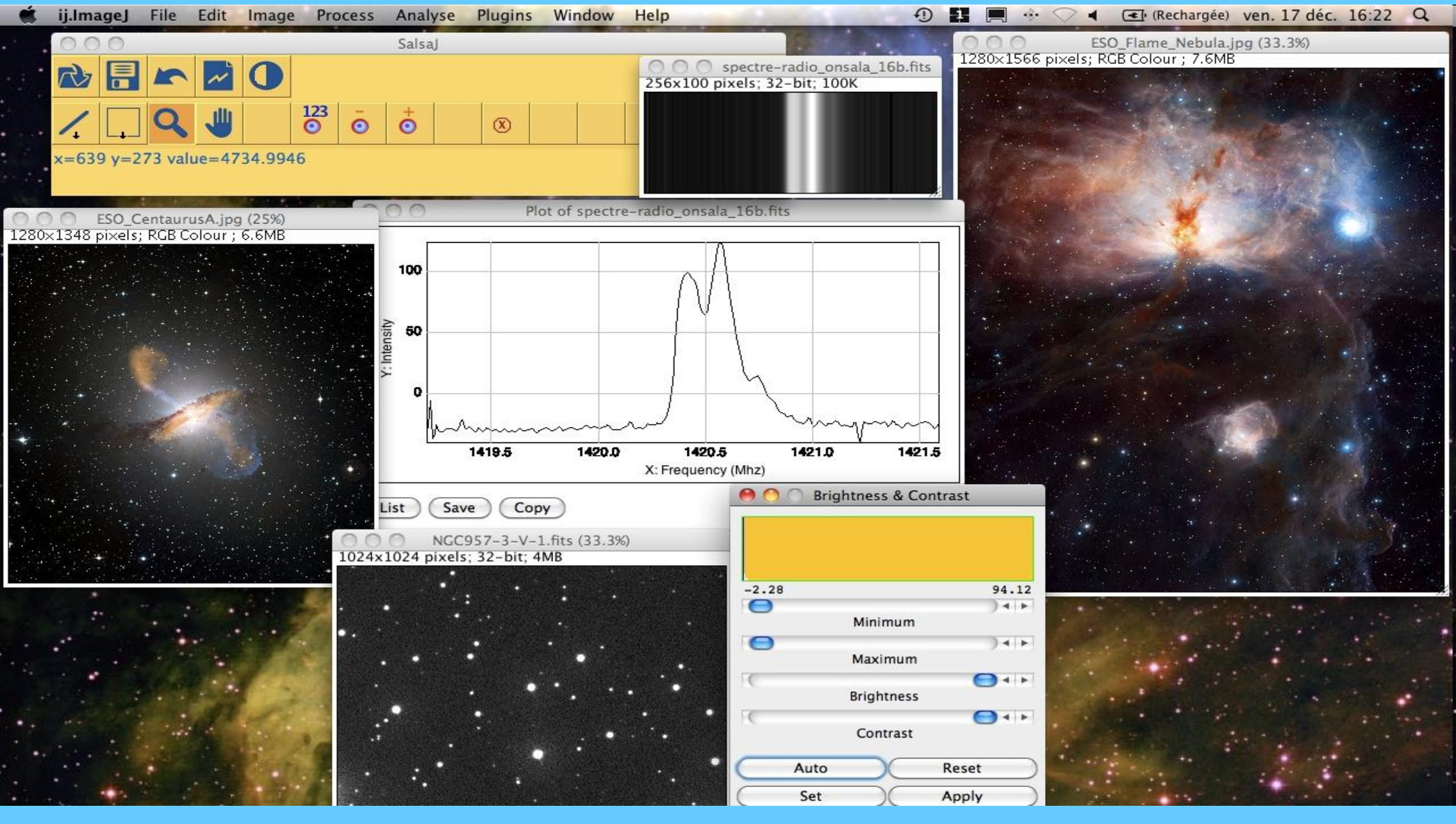
SalsaJ software

Didactical software for image and data handling

Such A Lovely Software for Astronomy, in Java

- ✓ Multi-platform (Windows, Linux, Mac)
- ✓ Java, modularity; easily extensible to implement new fonctionnalities
- ✓ Multilingual interface; also in arabic, chinese…
- ✓ Free of charge (download from the EU-HOU web site)
- ✓ Up to date sources (derived from the free medical research tool ImageJ developed at NIH); adapted to astronomy; friendly tool for classrooms

SalsaJ:
a multilingual interface



Pedagogical resources : exercises

Learning science by doing science: hands-on activities based on real astronomical data, inspired from research:

From the Doppler effect to extrasolar planets; transiting planets

Distances to Cepheids; estimation of the Hubble constant

The black hole at the centre of the Milky Way

How to weight a distant galaxy ? Rotation curve and dark matter

Radio astronomy in the classroom; hydrogen in the Milky Way

The solar System as a math laboratory

The HR diagram and the life of stars; stellar population

Craters and volcanoes in the solar System; Galilean satellites etc. etc…..

Supernovae portal ; Galaxy zoo

Distance to cepheids

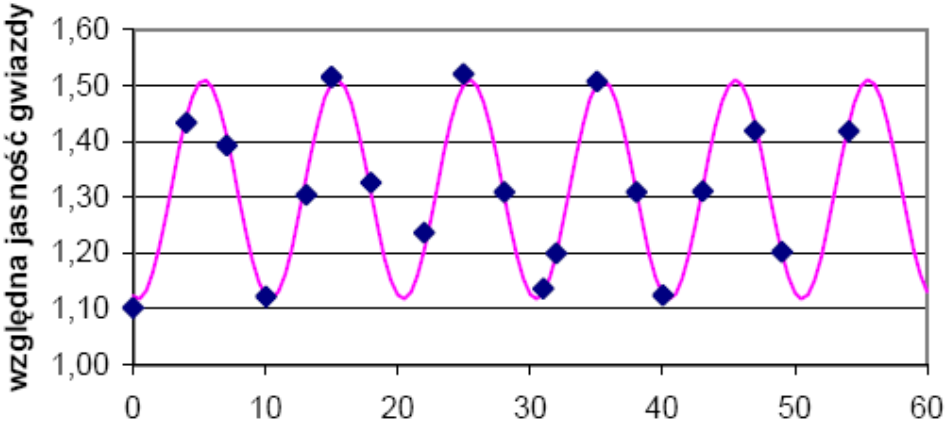


Fig.3 Example of a lightcurve

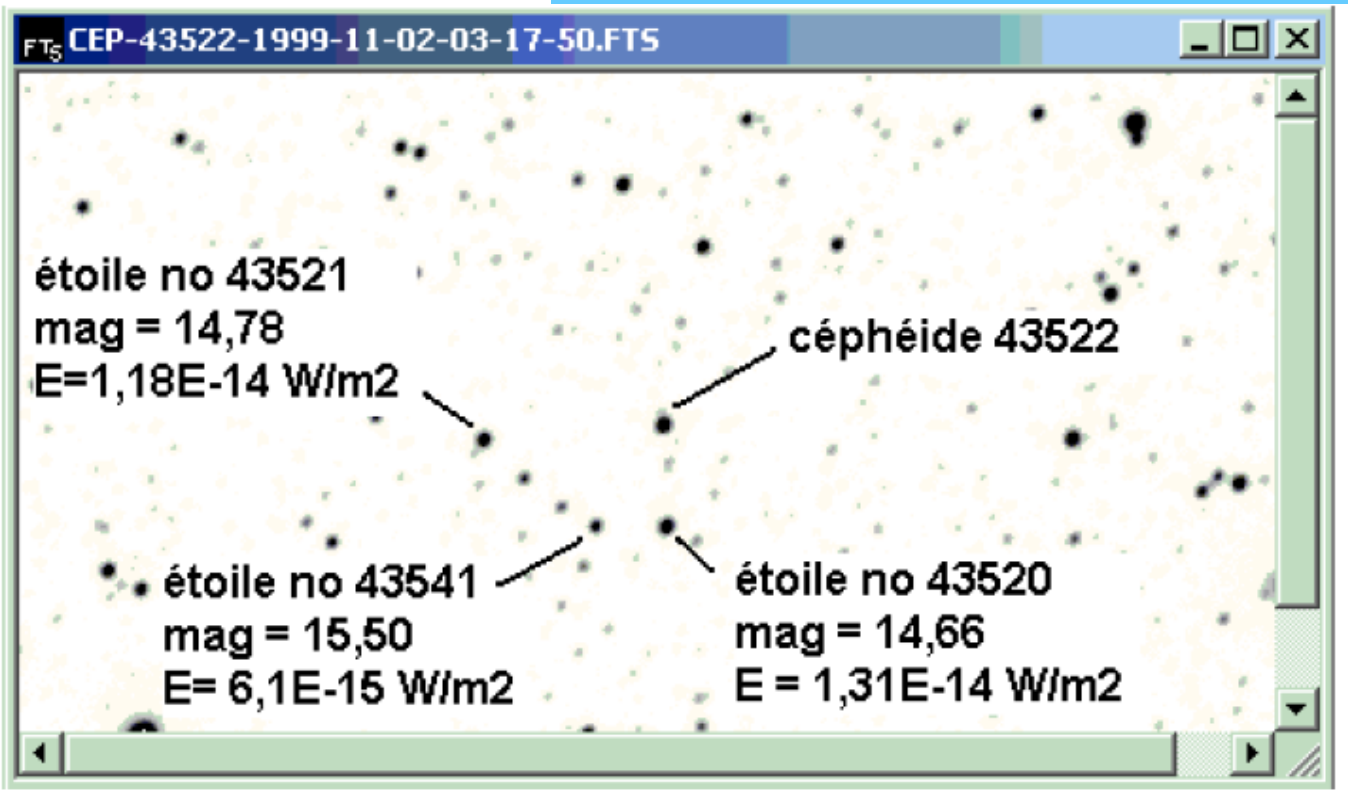


Fig.2 The location of the Cepheids and stars used for comparison.

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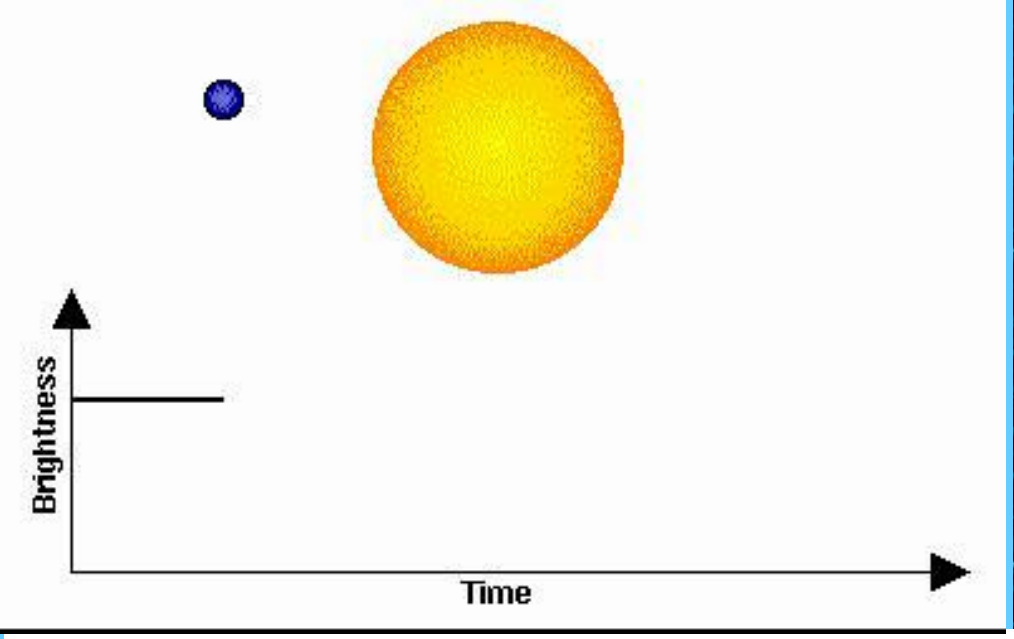
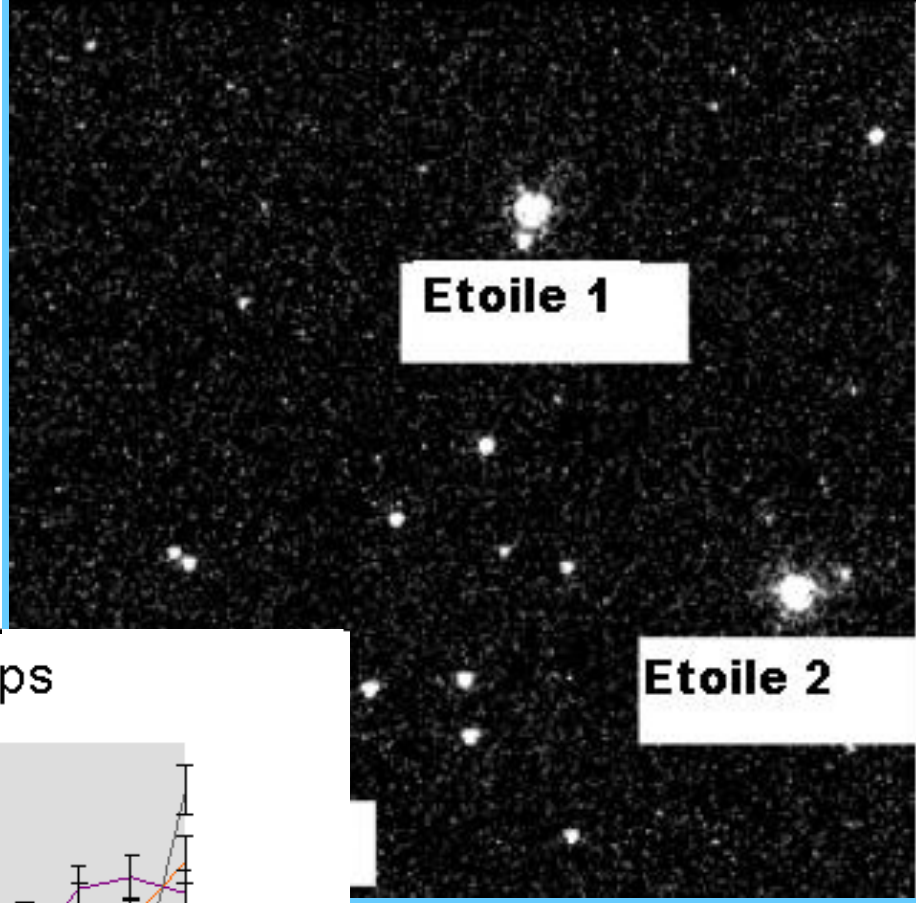
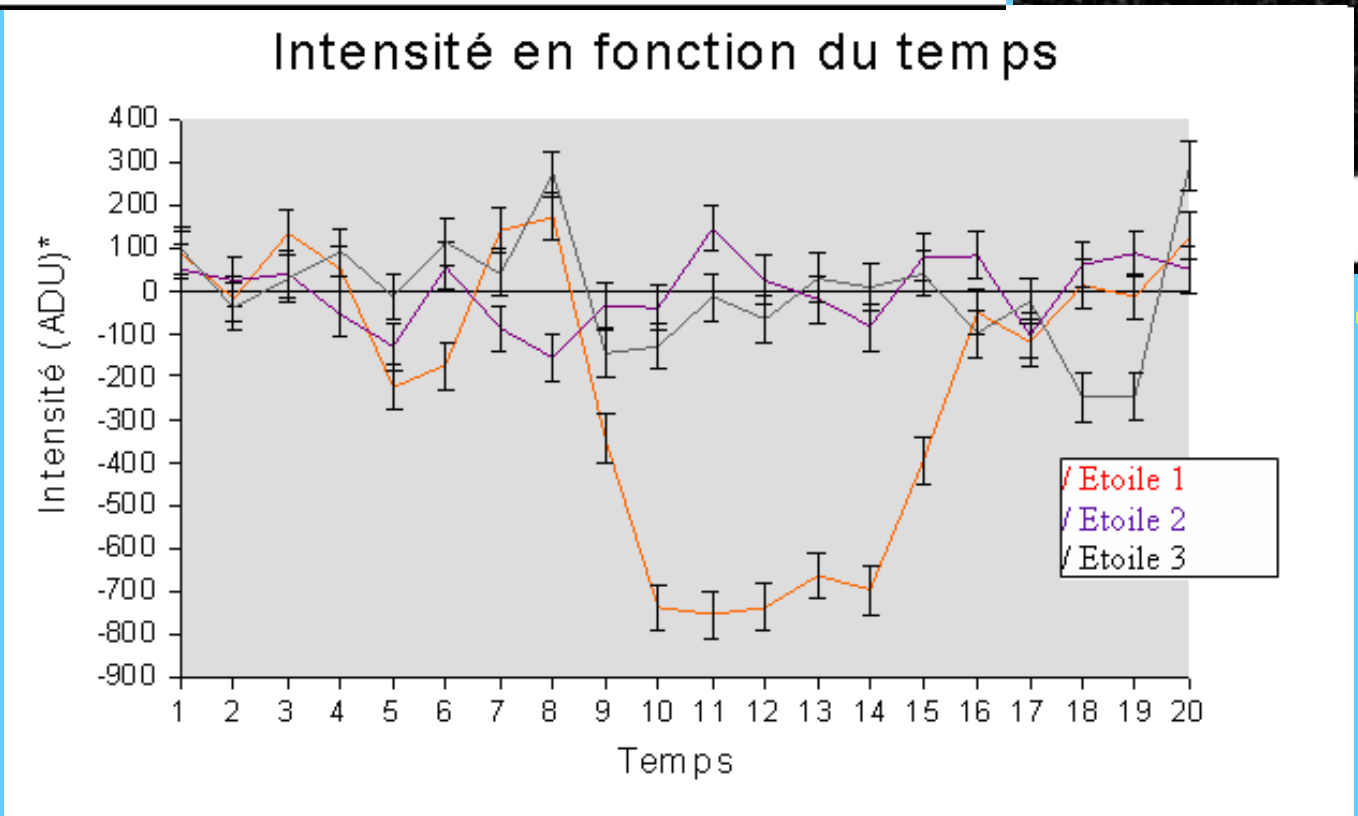
Bringing frontline interactive astronomy to the classroom







Transiting exoplanet

⟶ size

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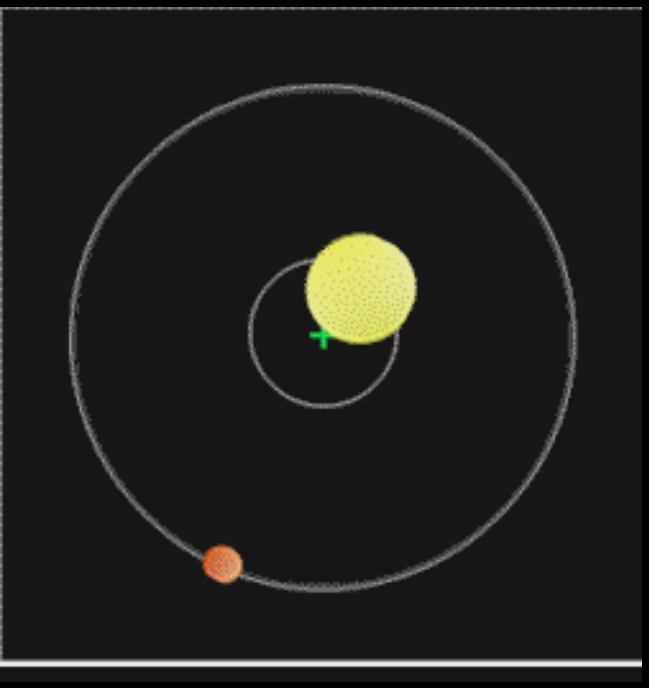
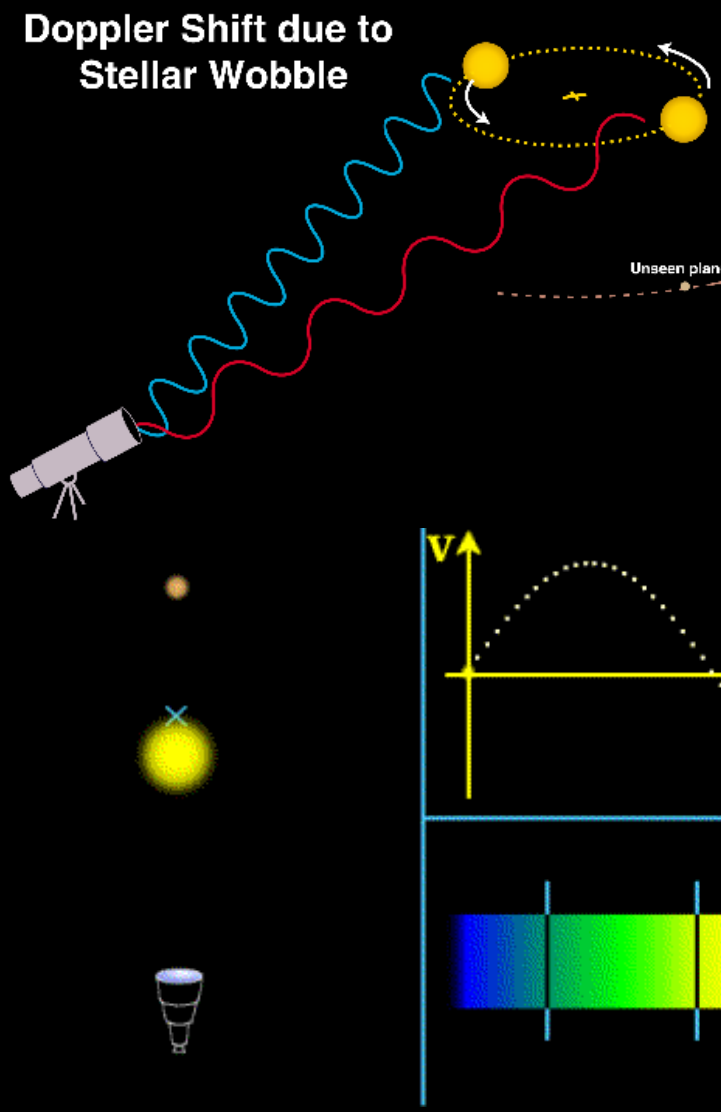
Bringing frontline interactive astronomy to the classroom





How to detect an extrasolar planet with the radial velocity method

→ mass

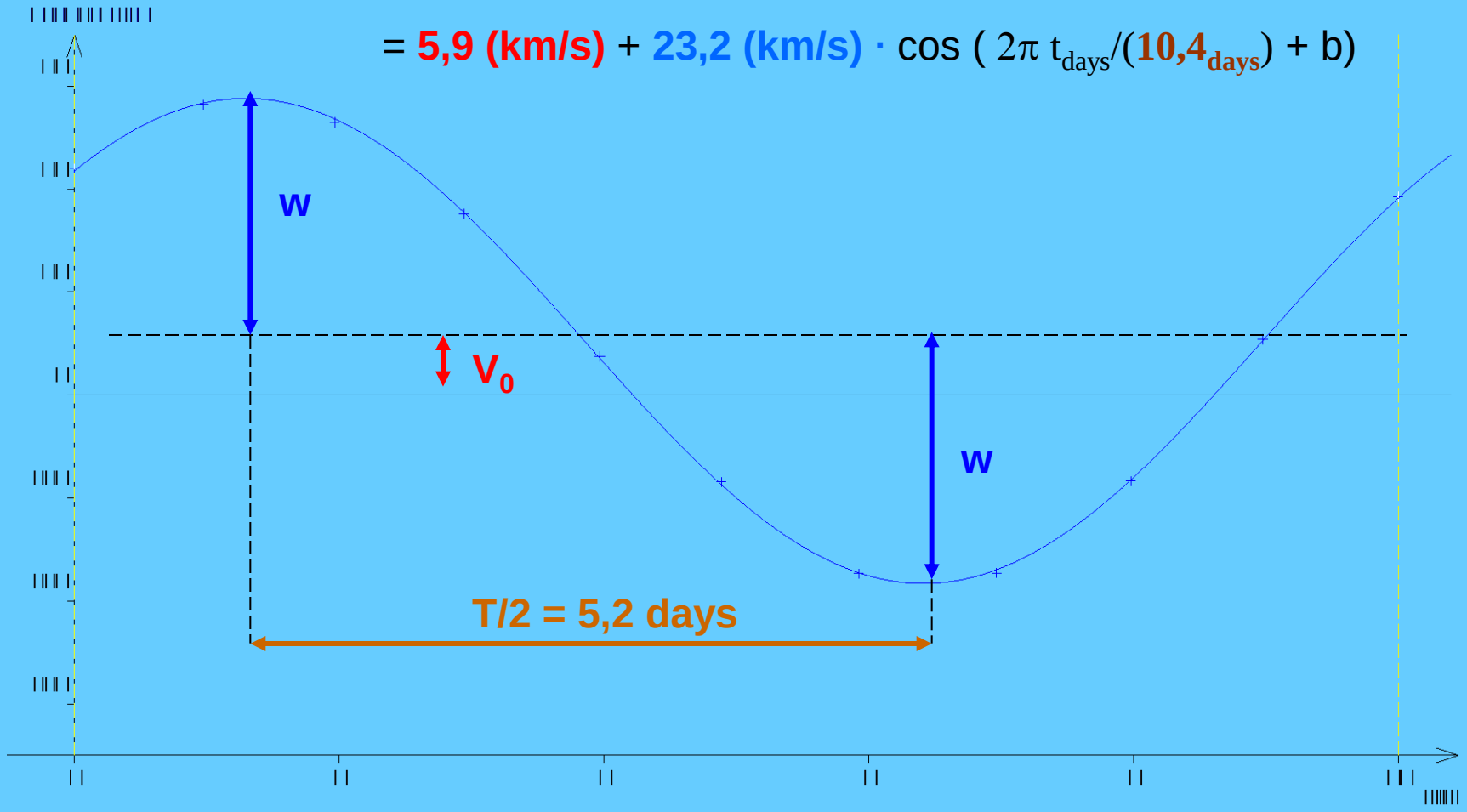
11 spectra

Spectre	Date t (days)	λ_1 (Å) 1 Å = 10^{-10} m	$\Delta\lambda = \lambda_1 - \lambda_{Na1}$ (Å) 1 Å = 10^{-10} m	$V_E = c.(\lambda_1 - \lambda_{Na1})/ \lambda_{Na1}$ (km/s)
1	0	5890,411	0.461	23.48
2	0.974505	5890,496	0.546	27.81
3	1.969681	5890,491	0.541	27.56
4	2.944838	5890,305	0.355	18.08
5	3.970746	5890,014	0.064	3.26
6	4.886585	5889,815	-0.135	-6.88
7	5.924292	4889,642	-0.308	-15.69
8	6.963536	5889,638	-0.312	-15.89
9	7.978645	5889,764	-0.186	-9.47
10	8.973648	5890,056	0.106	5.40
11	9.997550	5890,318	0.368	18.74

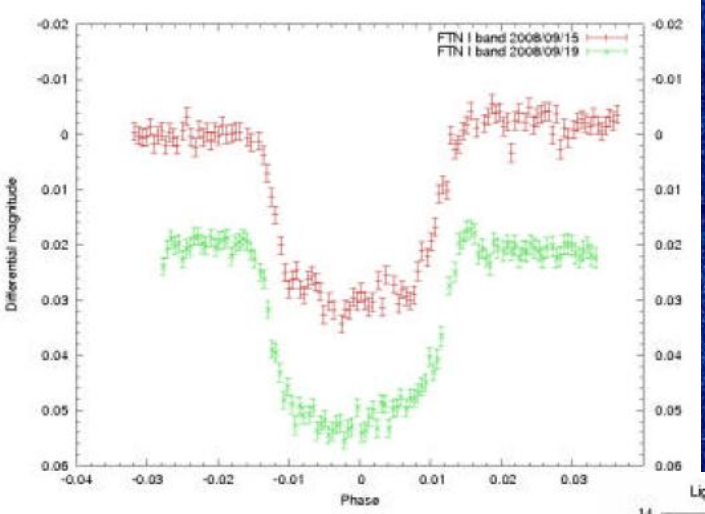
Radial velocity curve as a function of time

$V_{rad} = V_0 + W \cdot \cos (2\pi t/T + b)$

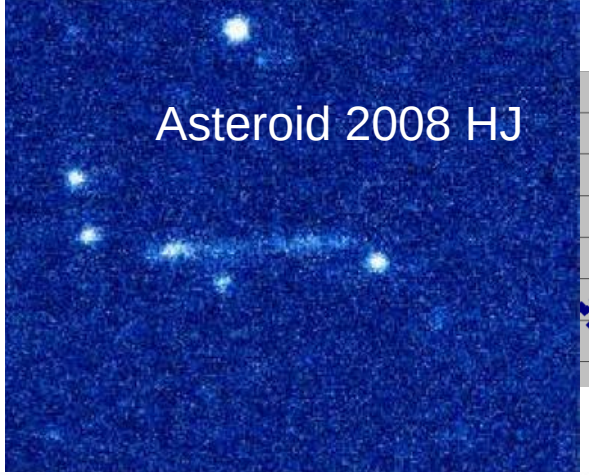
$= 5{,}9\ (km/s) + 23{,}2\ (km/s) \cdot \cos (2\pi\ t_{days}/(10{,}4_{days}) + b)$



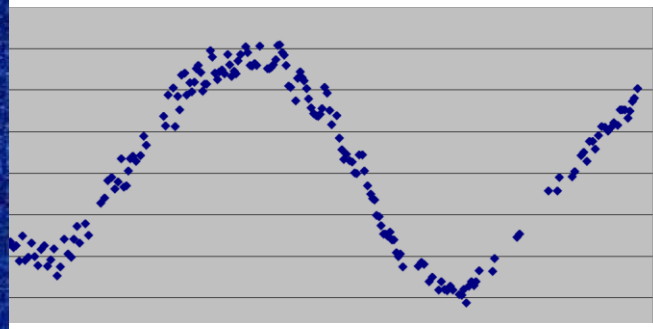
Kepler law ; m<<M → $m \sin i \approx (P/2\pi G)^{1/3} (V_{rad}) M^{2/3} (1 - e^2)^{1/2}$

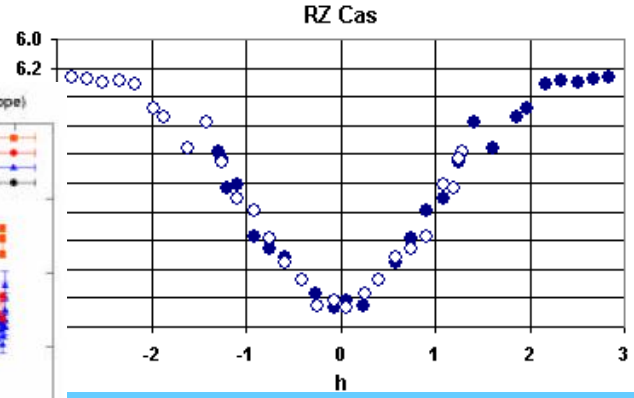


Extrasolar planet transit (WASP-10)

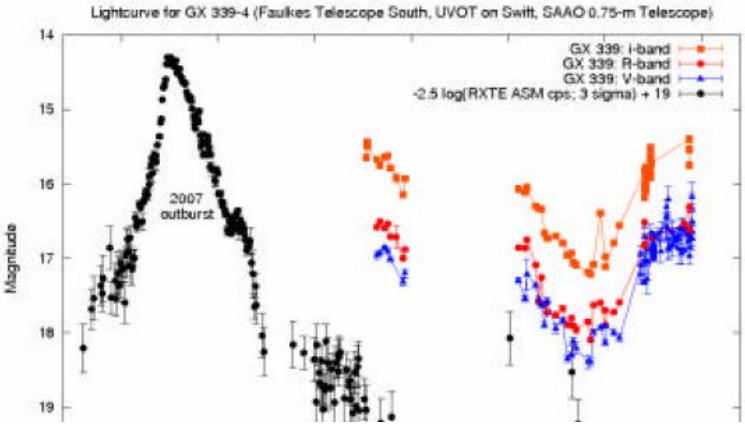


Rotation of asteroid Kleopatra

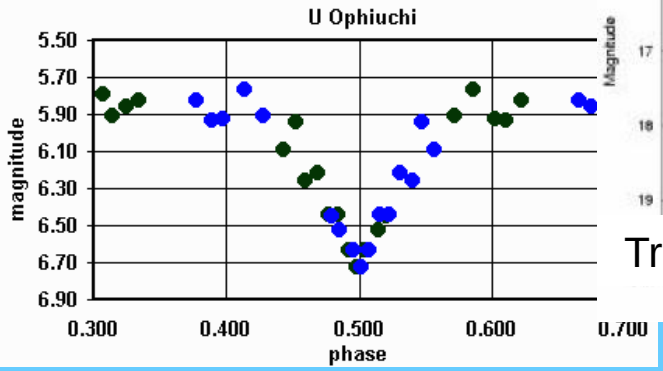




Variable stars



Transient black hole binary GX 339-4



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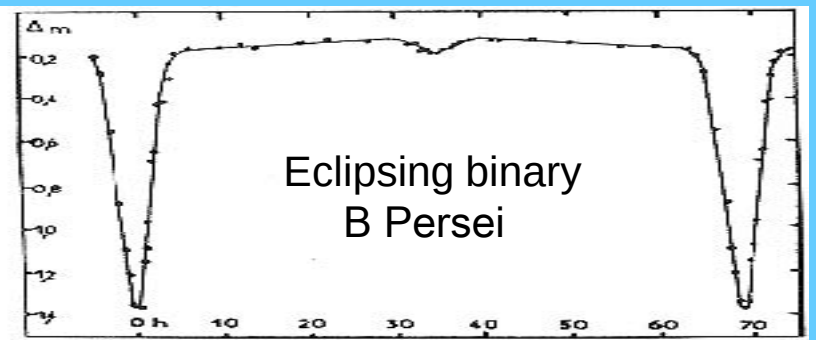
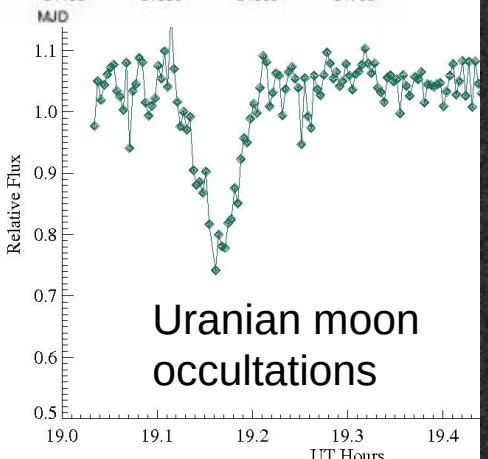
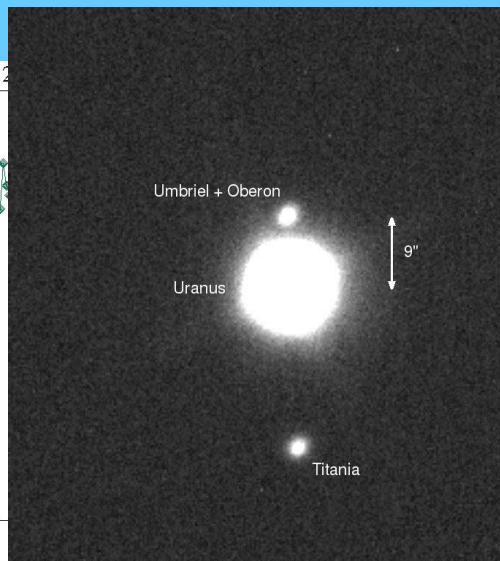
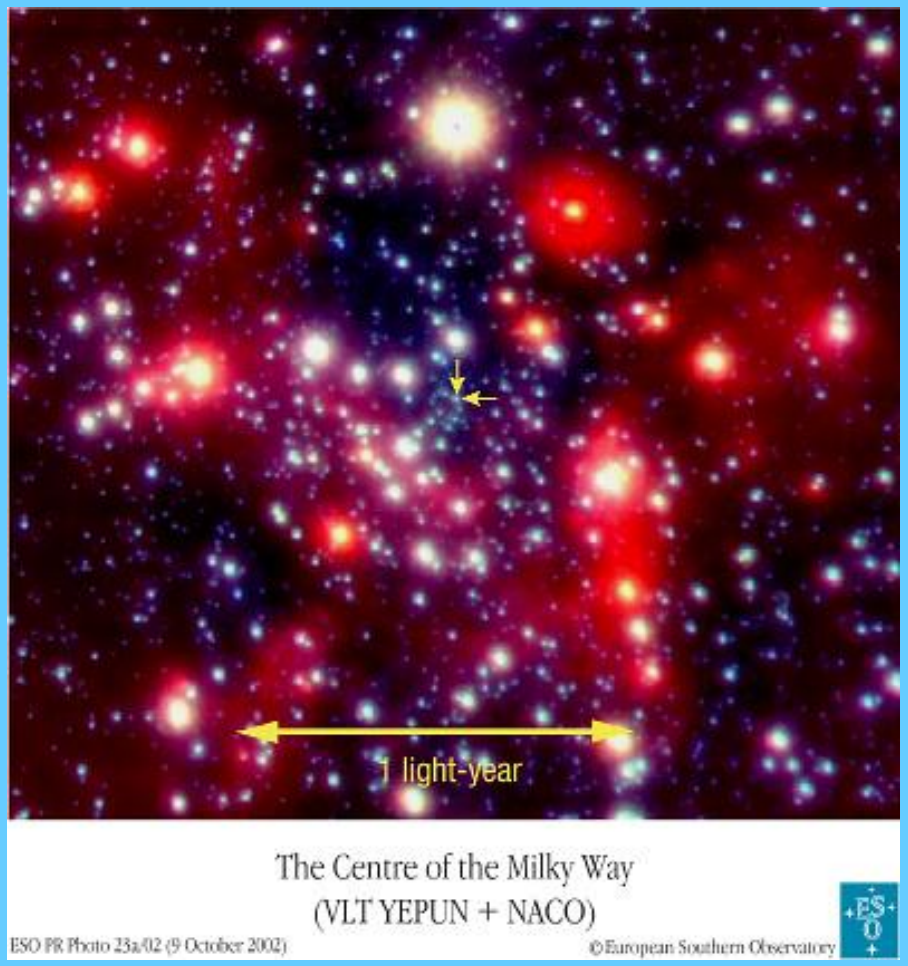
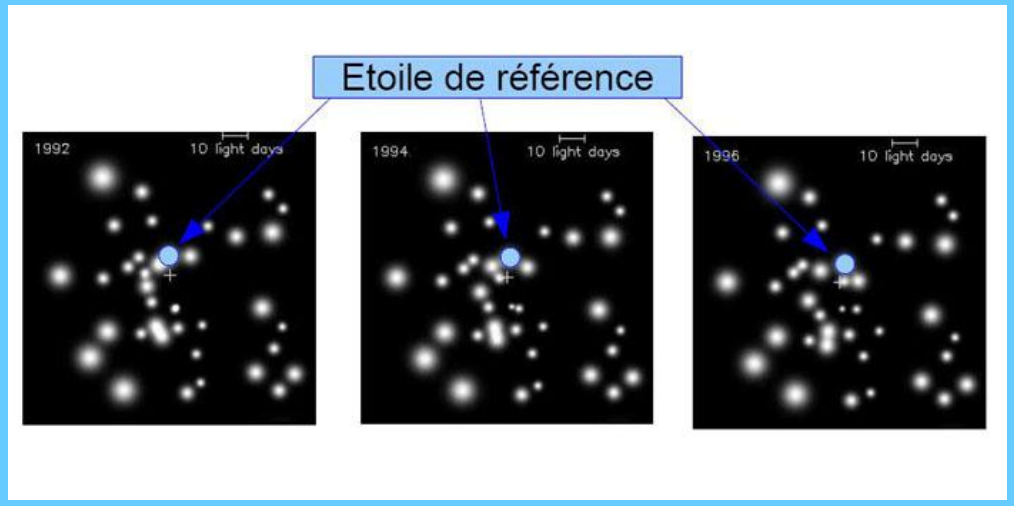


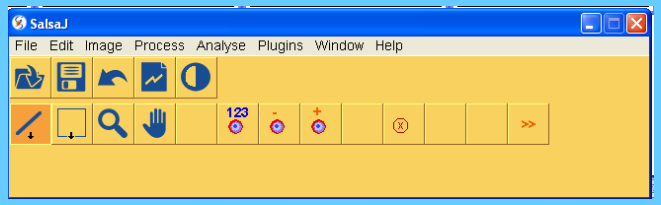


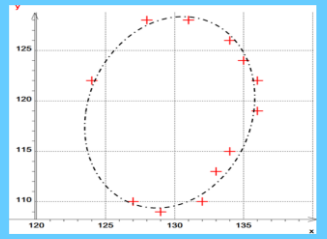


Mass of the black hole at the center of the Milky Way









- ➔ Almost complete rotation of the reference star
- ➔ Measurement of the semi-major axis
- ➔ Kepler's laws
- ➔ Mass of the black hole !

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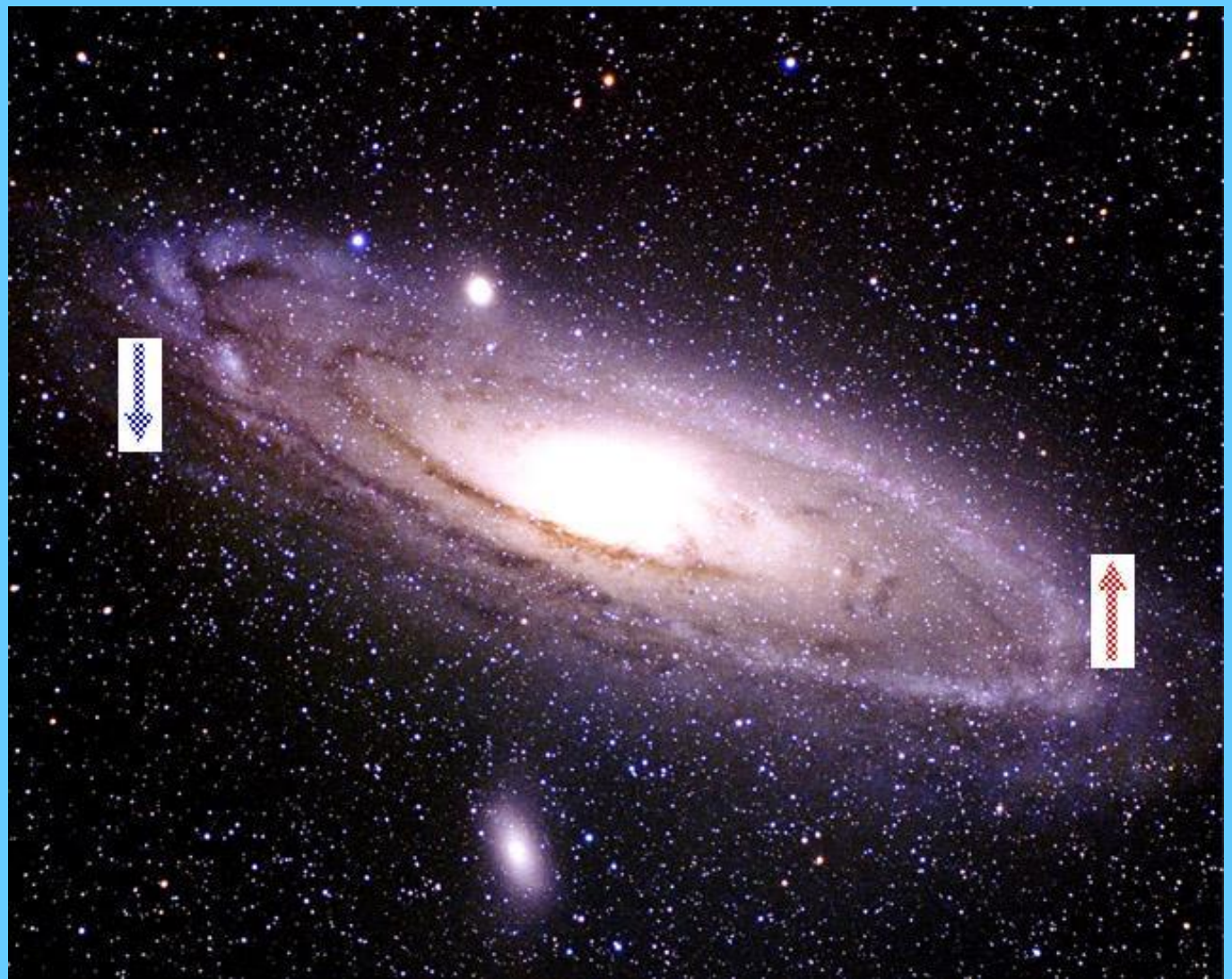
Bringing frontline interactive astronomy to the classroom

How to weight a galaxy ?



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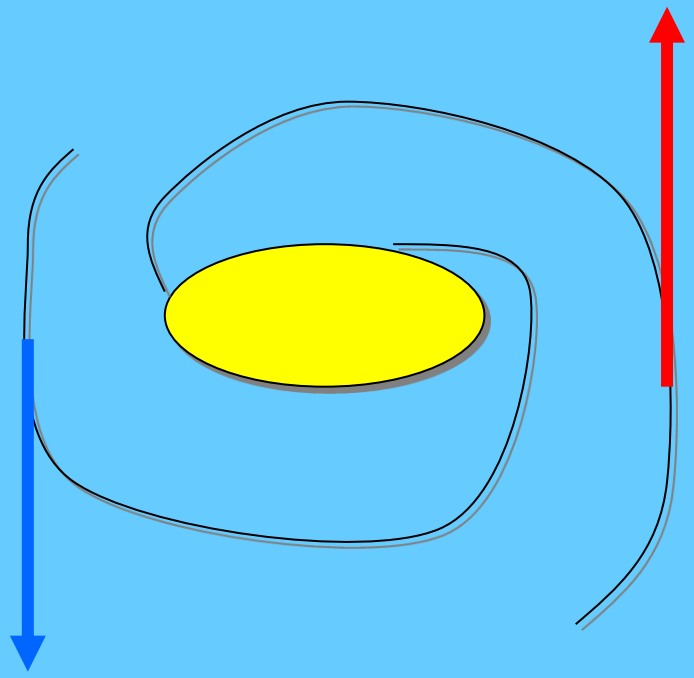
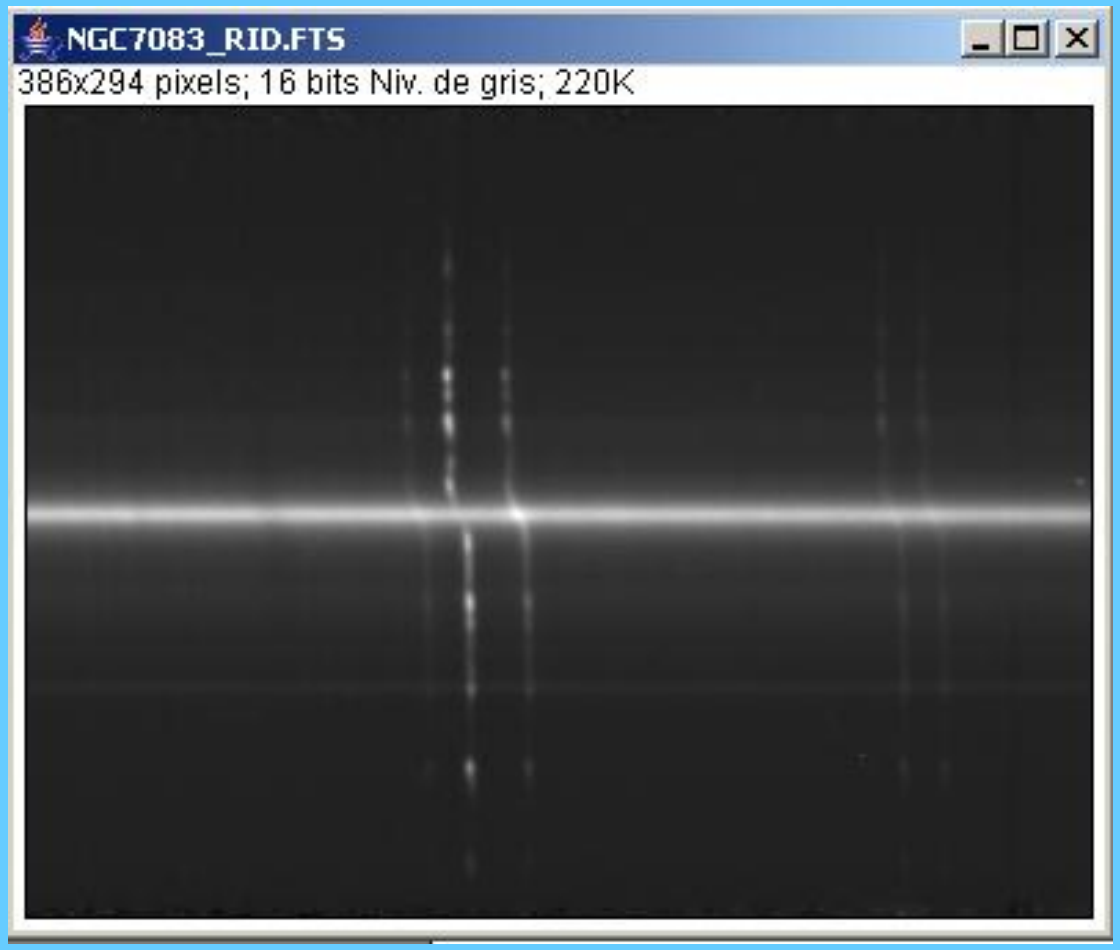
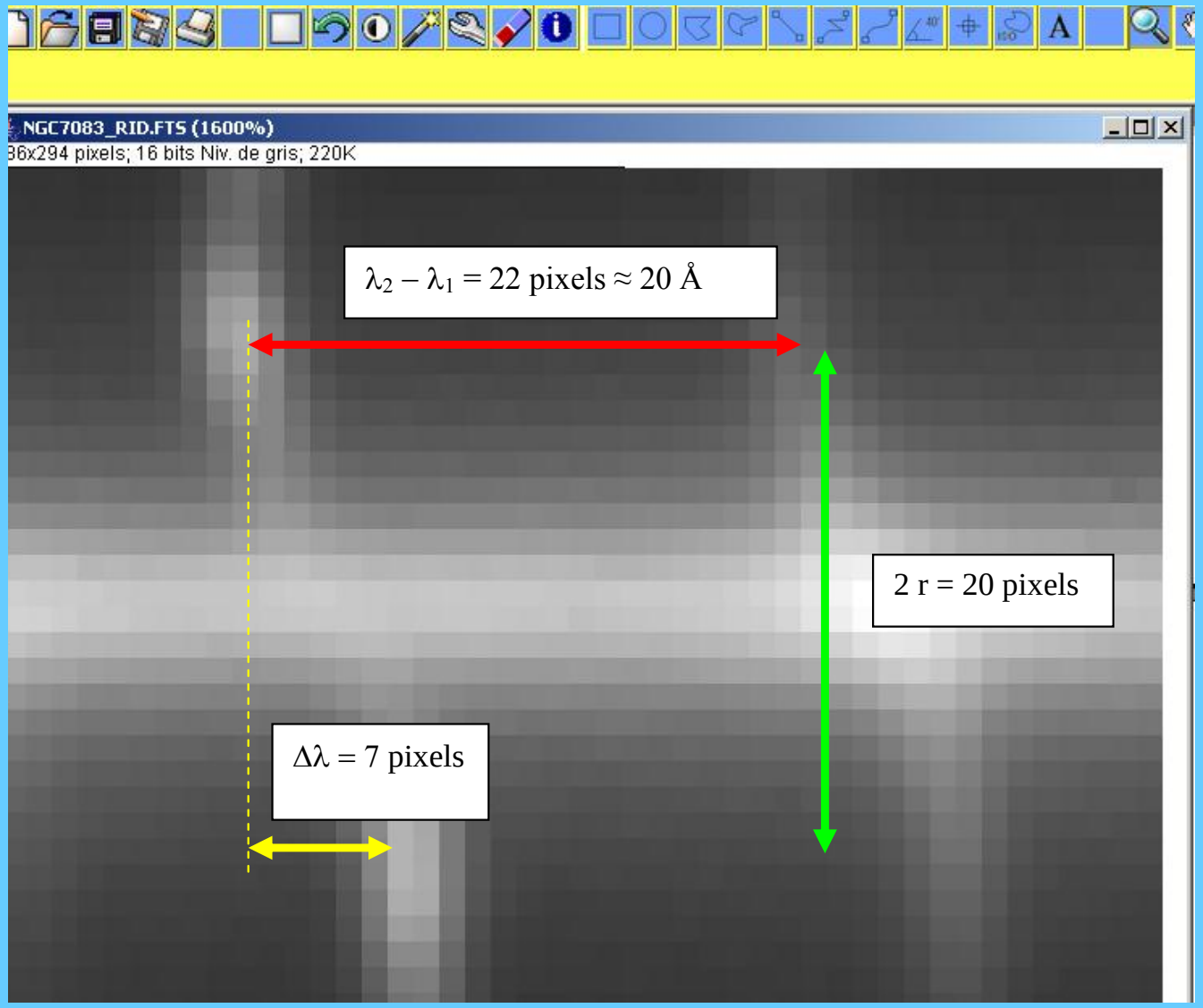
To weight a galaxy



$$\Delta\lambda / \lambda = 2\, v_{longitudinal} / c$$
$$= 2\, v \sin(i) / c$$





$\Delta\lambda / \lambda = 2\, v_{longitudinal} / c = 2\, v \sin(i) / c$

$M \approx 10^{40}$ kg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.euhou.net
2009: 44230 visits
2010: 47971 visits
About 4000 visits/month
About 1000 (teachers) which regularly visit the site ➔
120000 european pupils exposed to HOU
Important dates
Tools
News
Supernova in M100 !!!
The Life of Stars and their Spectra
Measuring Distances to Cepheids.
Annular Eclipse in Bragança (Portugal), 3 October, 2005
What is EU-HOU ?
Exercises
Software
Contact
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Teachers / Educators
Training
A learning and teaching experience
A global community of engaged educators

HOU is the leading team of

« Galileo Teacher Training Program »

a cornerstone launched by IAU and UNESCO for IYA 2009

Now included in the IAU decadal strategic plan for astronomy development

3rd price AMA09/Mani Bhaumik for *"Excellence in Astronomy Education and Public Outreach"*

EU-HOU-TTS

EU-HOU Teacher Training and Support program

The Comenius Life Long Learning program which ended on **31 Oct 2010**

Unveiling science excitation at schools through teachers – researchers collaboration using amazing real astronomical data.

- Production of new exercises in English and in different European languages.
- New release of *SalsaJ*.
- Use of worldwide telescope networks, optical and radio, operated via Internet.
- Enlargement of the existing network of researchers and teachers to bring actual research data into classrooms for inspiring pupils.
- Updating of our web site with a free access multilingual portal to all available resources, with means for sharing experience.
- Dissemination through teacher training sessions.

Hundreds of European teachers trained.
Thousands of European pupils have used HOU tools.

Cardiff – 22-25 August 2009

Torun – 5-8 May 2010

OHP – 7-10 May 2009

EU-HOU-MW

EU-HOU – Connecting classrooms to the Milky Way

A Comenius EU-Commission « Life Long Learning Program » : Nov 2010 – Oct 2012

coordinated by Université Pierre & Marie Curie

Development of the first european network
of **radiotelescopes** for education,
opening a new window on the Universe to explore
the Milky Way from schools via **Internet** (via a browser)

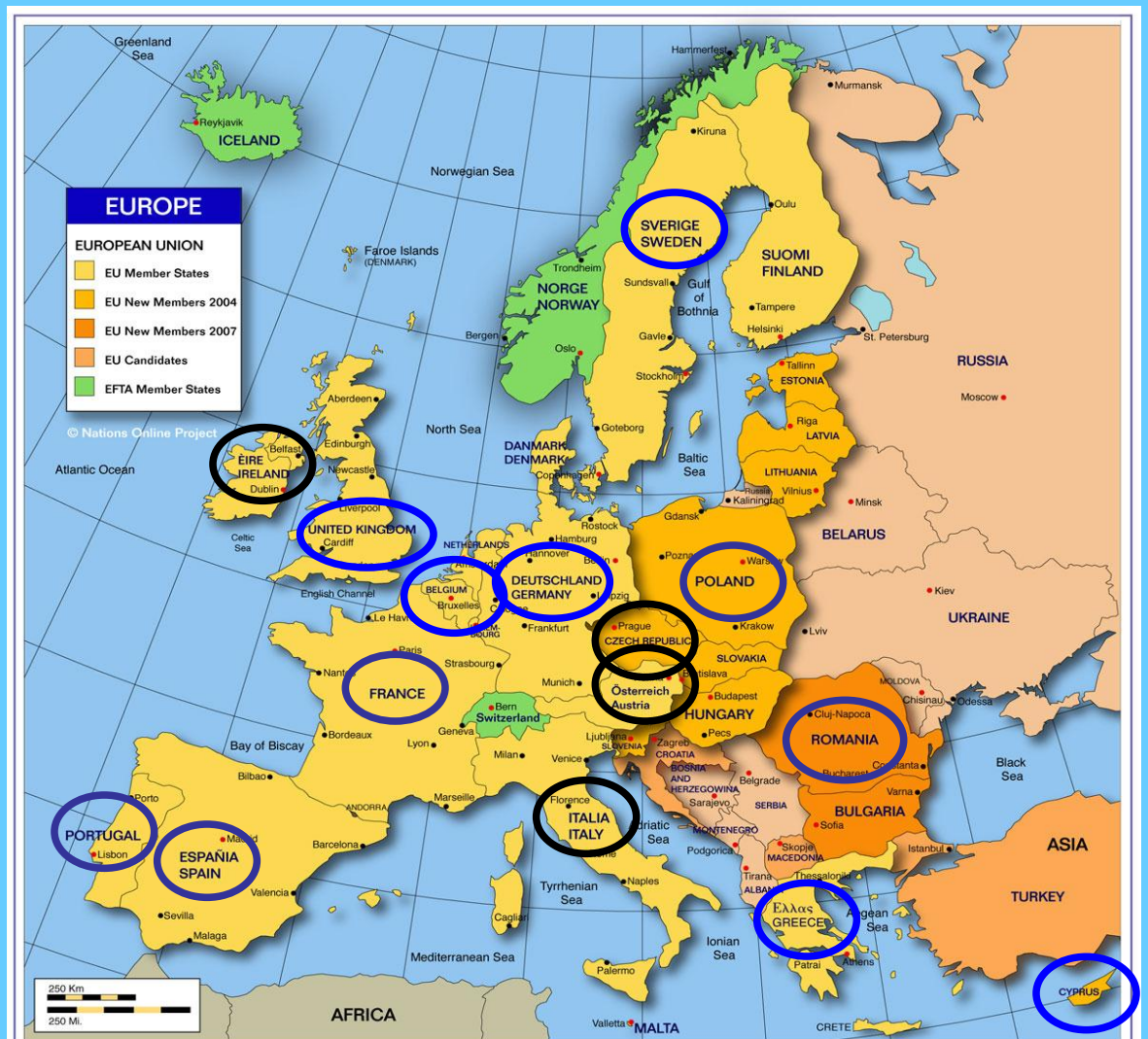
Development of pedagogical ressources for classrooms
(exercises based on radio data, exhibitions…)

UPMC PARIS UNIVERSITAS — LERMA — cnrs dépasser les frontières — l'Observatoire de Paris

EU-HOU-MW

Comenius project

11 European countries



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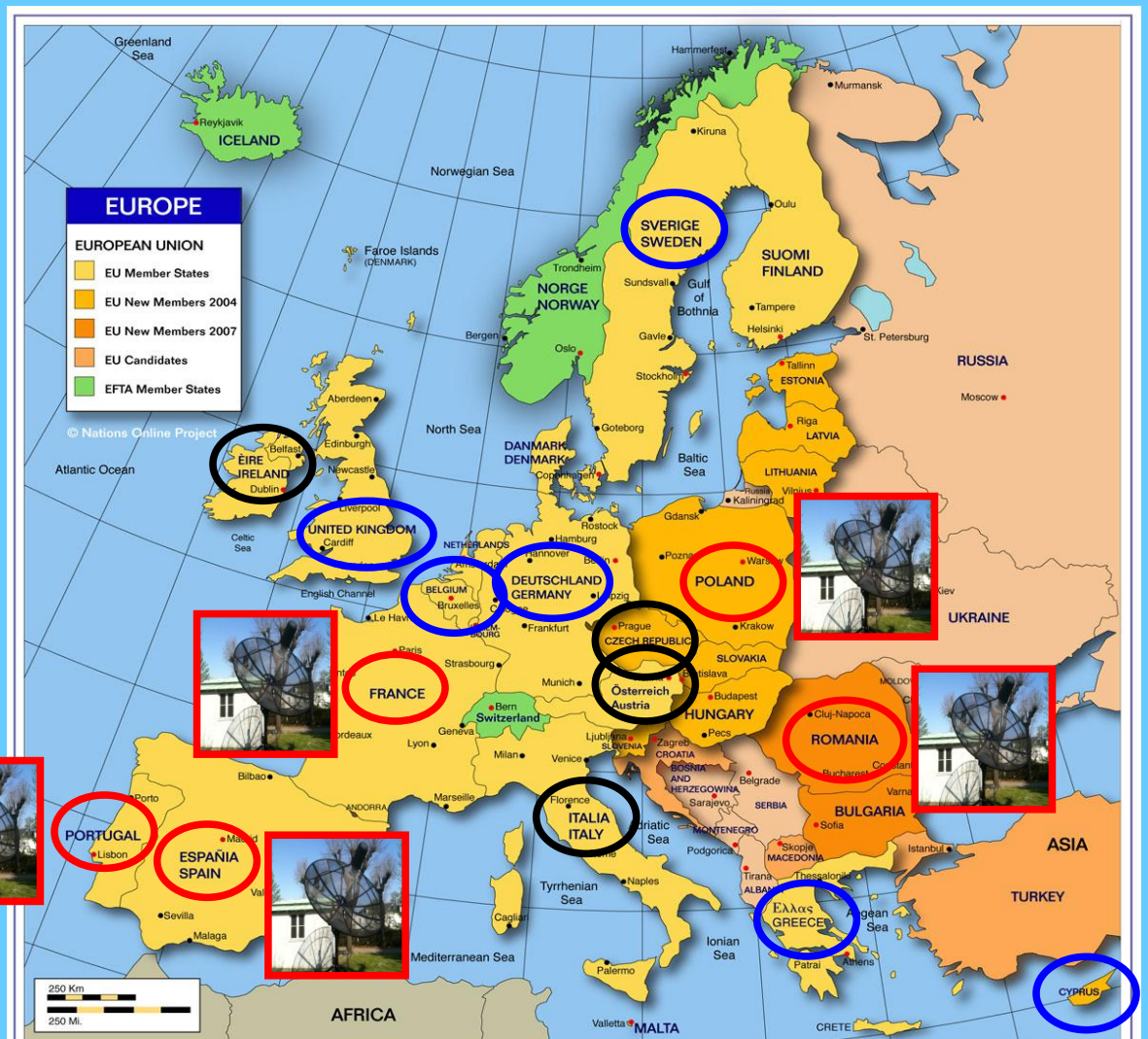
Radiotelescope Network

5 European countries



EU-HOU-MW

Small radio antenna prototype

Université Pierre et Marie Curie (France) - *F-HOU Coordinator*
Förderverein Astropeiler Stockert e.V. (Germany)
Observatoire royal de Belgique
Lykeio Agiou Nikolaou (Cyprus)
National Observatory of Athens (Greece)
Jagiellonian University (Poland)
Nucleo Interactivo de Astronomia (Portugal)
Universitatea din Craiova (Romania)
Universidad Complutense de Madrid (Spain)
House of Science (Sweden)
Glamorgan University (United Kingdom)

Kick-off meeting in Paris

EU-HOU-MW

Small radio antenna prototype

Diameter: 2.3m

Resolutions:

spatial: 7deg.

spectral: 40kHz

SRT(Small Radiotelescope) Haystack Observatory Cassi Corps/USA

EU-HOU-MW

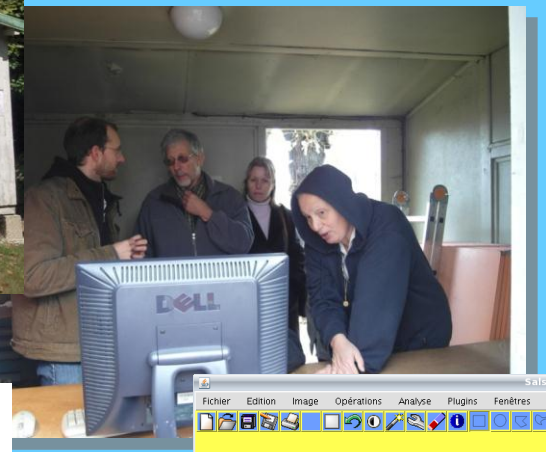
Small radio antenna prototype

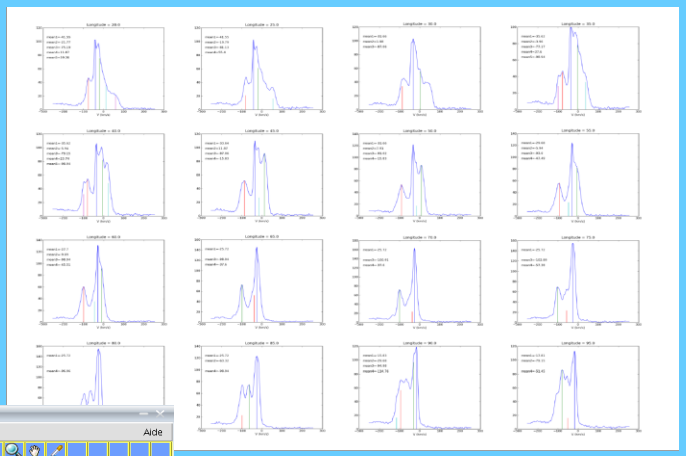
- Provide a scheduling system to access the telescope
- Provide a remote access to the 5 telescopes
- Provide a simulator mode to perform the exercise with high quality data (LAB survey)

EU-HOU-MW

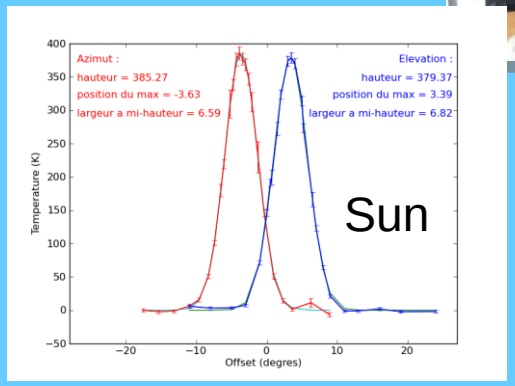
Small radio antenna prototype

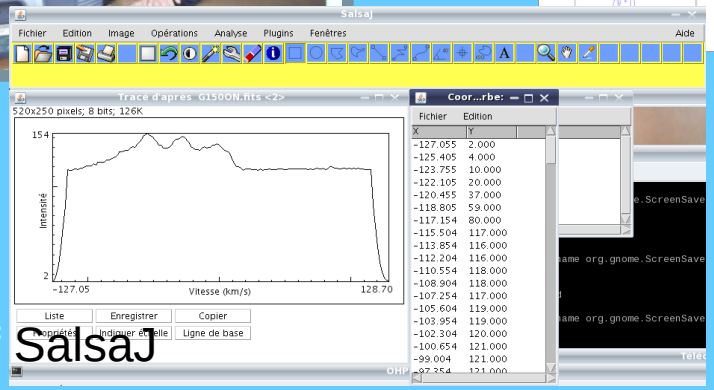
- Software development (python…)
- Calibrations (noise, flux…)
- Data reduction (baseline, platforming, parasites…)





Line velocities automatic identification **(Onsala data)**





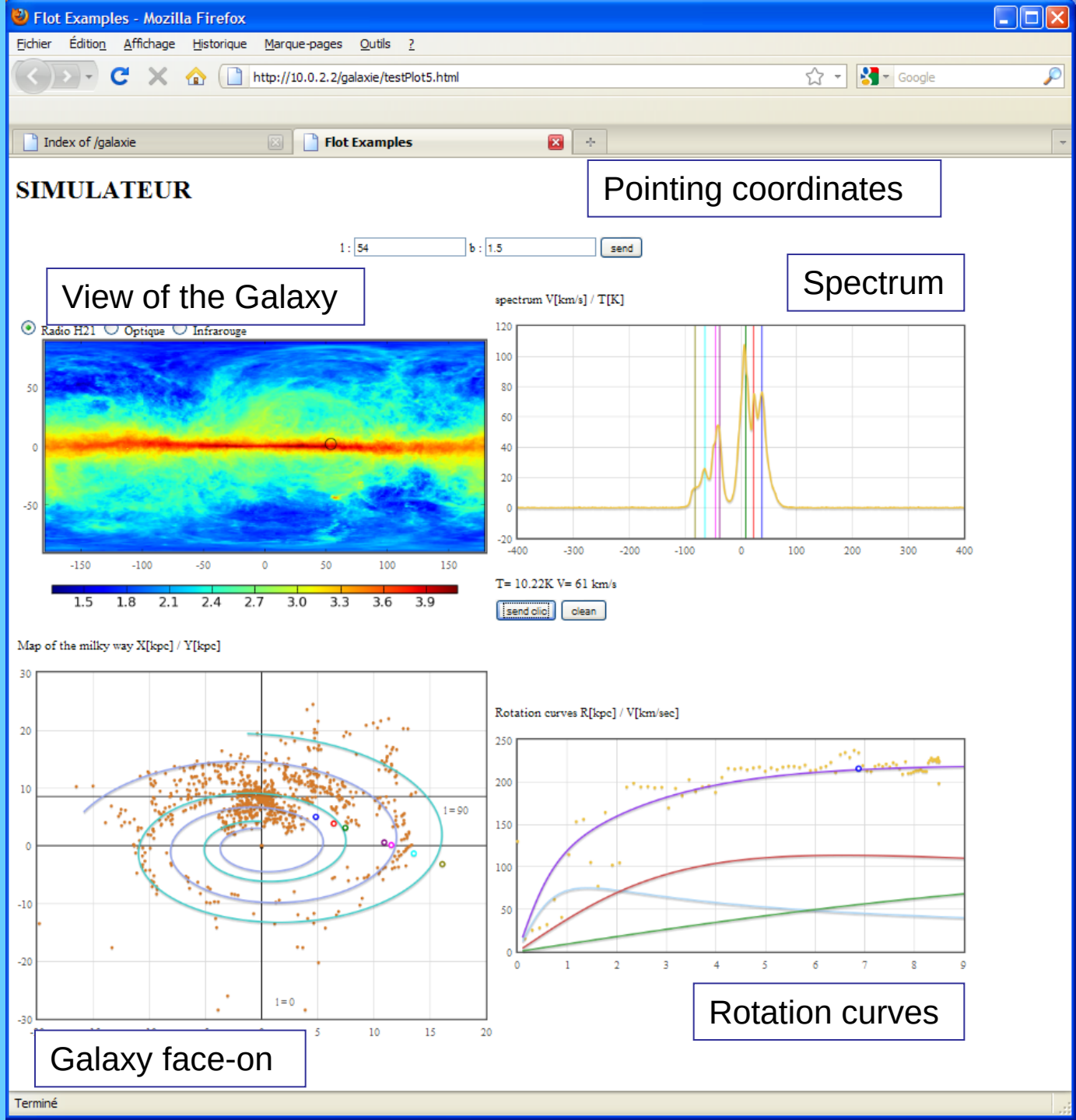
Use of SalsaJ

3 developments

- Simulator
- Web interface for piloting SRTs
- Analysis: rotation curve and spiral arms

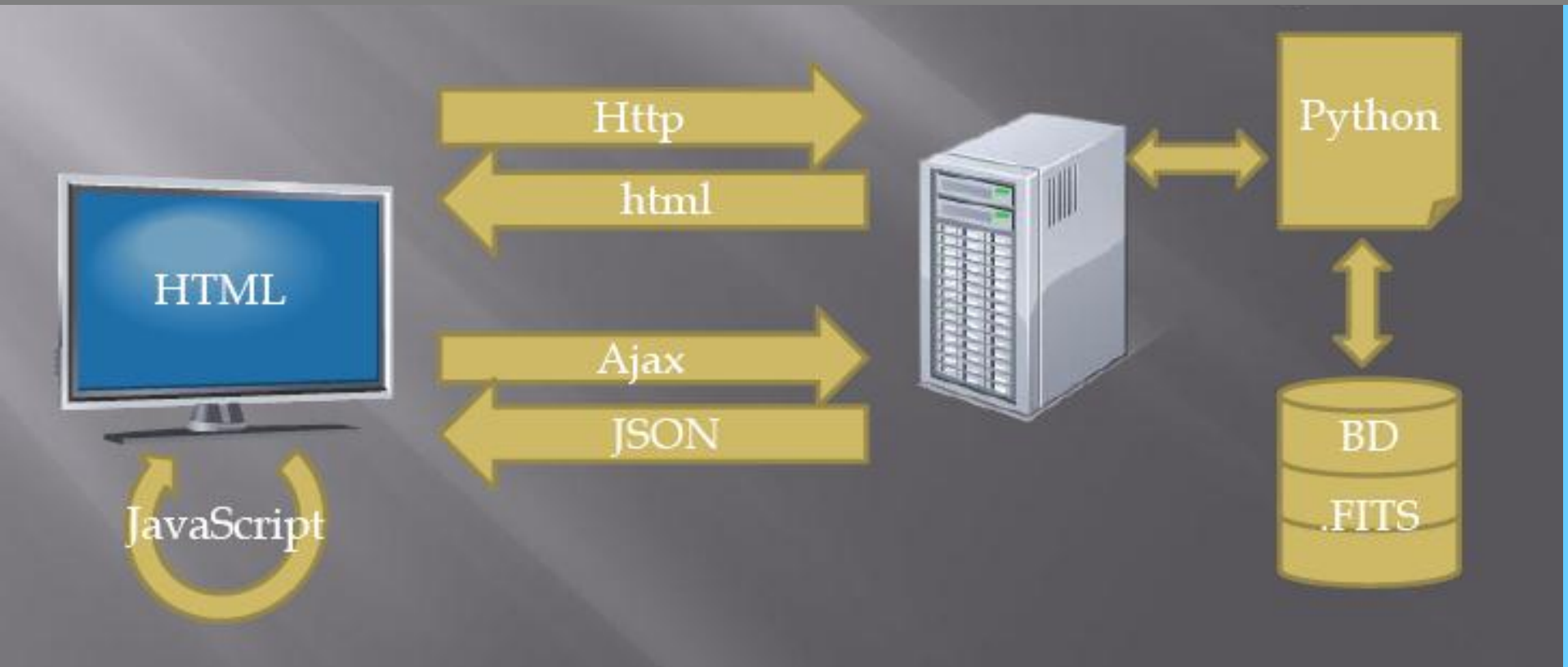
Teacher training

Portugal April 2011



SIMULATOR : http://195.83.118.5/~hou-mw/simu.html

- Simulation of a radio telescope observation from an Internet page
- Use of the data from the LAB Survey



Other on-going activities

- Collaboration with « Sciences à l'école » for training, equipment, curriculum…
- Workshop at the annual national meeting of French physics teachers: ~ 100 teachers trained to exercises
- Implementation in some « Académies » of teacher training focused on:

remote observations ; photometry ; spectroscopy ; at OHP including observations (two days, large success)

- New exercises: equinoxes precession; gravitational microlensing, speed of light…..
- European training sessions within the European Comenius action :

EU-HOU - Bringing frontline interactive astronomy in the classroom - 5-days training sessions

17-21 October 2011 : Observatorio Astronomico de Coimbra, Portugal
17-21 October 2011 : Argelander-Institut für Astronomie, Bonn, Germany
14-18 November 2011 : Université Pierre et Marie Curie, Paris, France
12-16 March 2012 : Observatorio Astronomico de Coimbra, Portugal
2-6 April 2012 : Université Pierre et Marie Curie, Paris, France
21-25 May 2012 : Observatorio Astronomico de Coimbra, Portugal
4-8 June 2012 - Université Pierre et Marie Curie, Paris, France

EU-HOU - Connecting classrooms to the Milky Way- 2-days seminars

6-7 February 2012 : Université Pierre et Marie Curie, Paris, France
26-27 March 2012 : Argelander-Institut für Astronomie, Bonn, Germany

European teacher training Comenius

Monday	Tuesday	Wednesday	Thursday	Friday
9h00-10h30: Course. General introduction	**9h00-10h30: Course. Spectroscopy**	**9h00-10h30: Course. Cosmology and black holes**	**9h00-10h30: Course. Extrasolar planets, impacts in the solar system**	**9h00-10h30: Course. Presentation of the EU-HOU project**
10h30-11h Coffee	10h30-11h Coffee	10h30-11h Coffee	10h30-11h Coffee	10h30-11h Coffee
11h00-12h30 TP. Galileoscope assembling/On-line observations	**11h00-12h30 TP. Building of a spectroscope/On-line observations**	**11h00-12h30 TP. Sun4all/On-line observations**	**11h00-12h30 TP. Hydrogen study of the Milky Way/On-line observations**	**11h00-12h30 TP. Registration on the EU-HOU forum. Introduction to the Web site**
12h30-14h Lunch	12h30-14h Lunch	12h30-14h Lunch	12h30-14h Lunch	12h30-14h Lunch
14h-17h TD TICE with SalsaJ. Introduction to SalsaJ, power of 10	**14h-17h TD TICE with SalsaJ. Distance measurement in the Universe: type Ia supernovae; Cepheides**	**14h-17h TD TICE with SalsaJ. Dark matter, rotation curve of a galaxy, black hole of the Milky Way**	**14h-17h TD TICE with SalsaJ. Craters and impacts in the solar system**	**14h-17h. TD TICE with SalsaJ. Detection of extrasolar planets (radial velocities and transits)**

THANK YOU

EU-HOU

http://www.euhou.net

Education and Culture
Socrates

Education and Culture DG
Lifelong Learning Programme

Sciences à l'École
LUNAP
L'Univers à portée de main

F-HOU
L'Univers à Portée de Main
LERMA

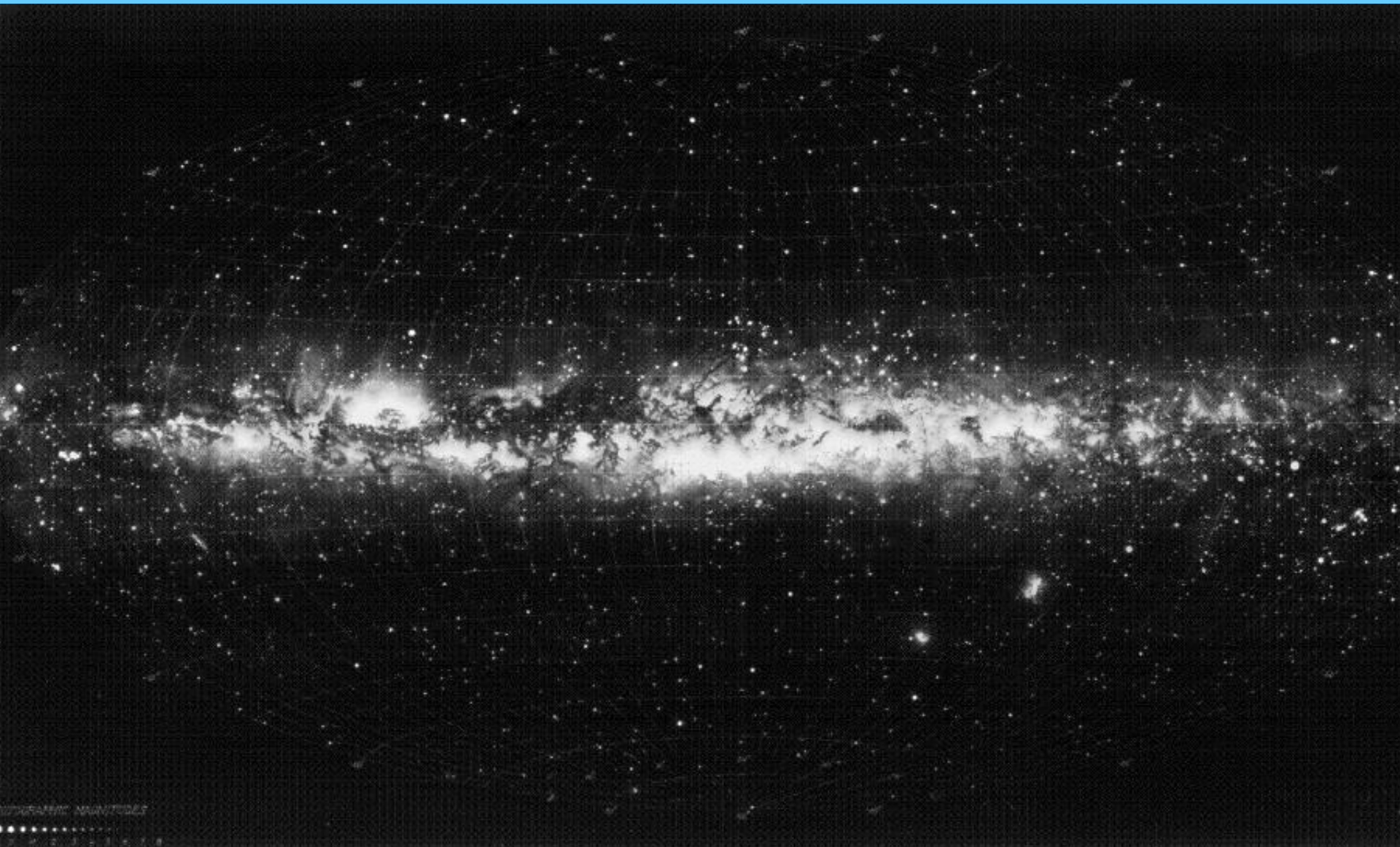
UNIVERSITE PIERRE & MARIE CURIE
LA SCIENCE A PARIS

IAP

The project is supported by European Union, Directorate General for Education and Culture, Socrates/MINERVA action

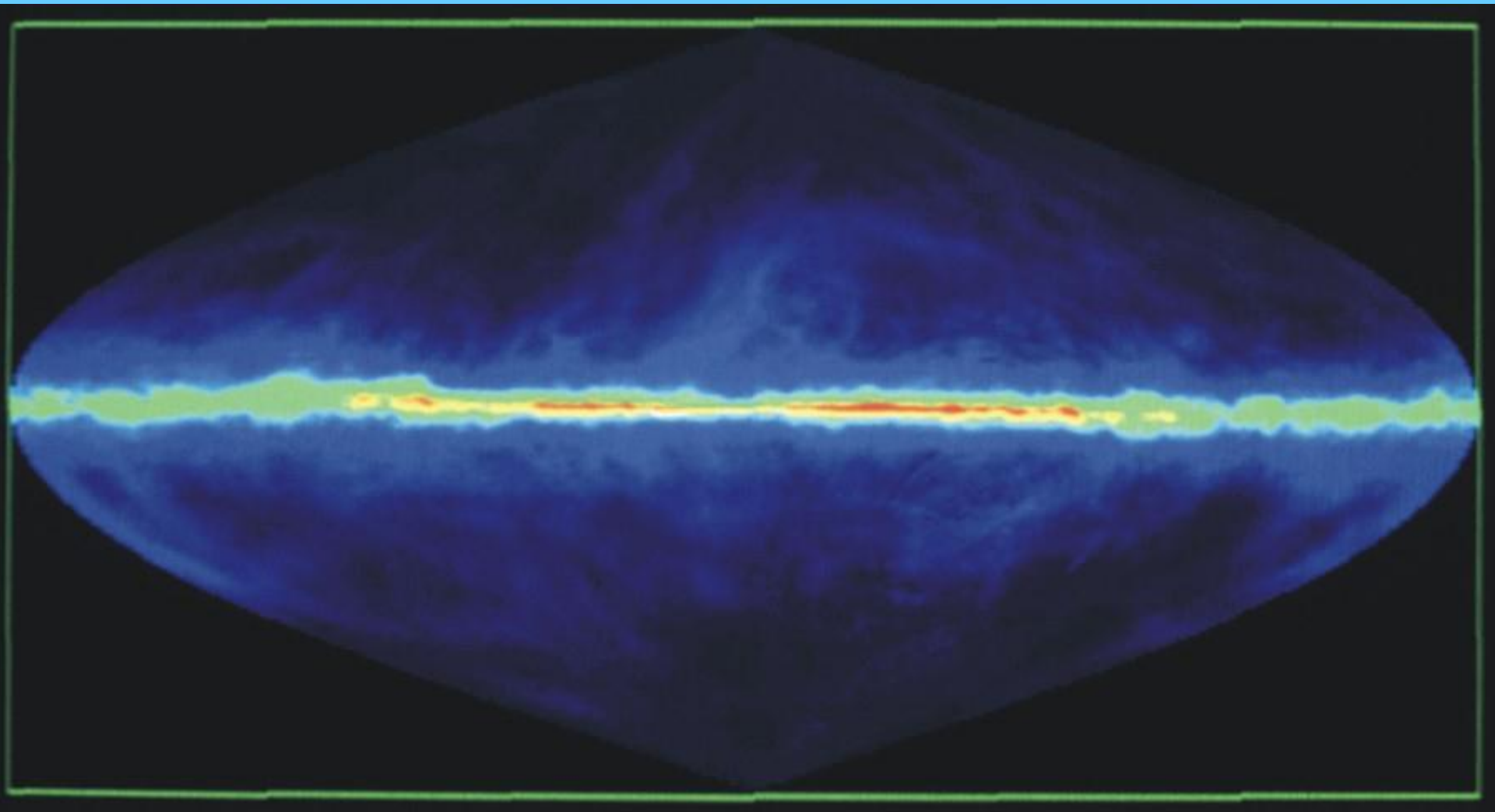
Logo designed by Armella Leung,
www.armella.fr.to

Milky Way : visual wavelengths



Milky Way : microwave (COBE)

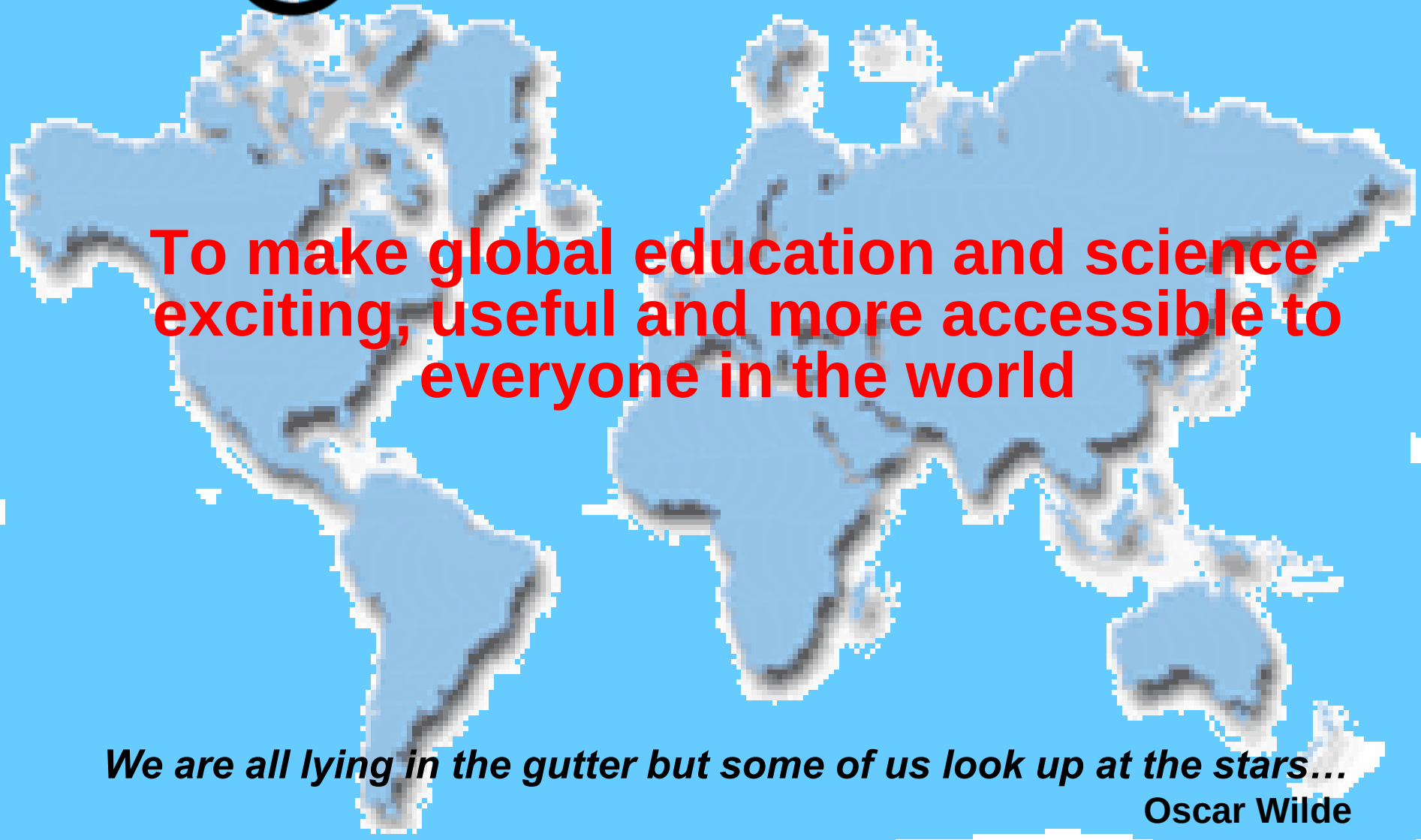
Milky Way : 21 cm H I map



Developing Global Hands-on Universe

G-HOU

Bringing frontline interactive astronomy to the classroom



To make global education and science exciting, useful and more accessible to everyone in the world

We are all lying in the gutter but some of us look up at the stars…

Oscar Wilde