

# The Virtual Observatory for Education

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# VO 4 Edu and Euro-VO

The goal, since 2008:

- Spark the interest on and share the excitement of research in astronomy
- Let students experience the astronomer's work in the classroom

Target:

- Mainly 13 yr to 18 yr old students + university

# VO 4 Edu and Euro-VO

How:

- Astronomical data from professional archives
- Software tools adapted from the researchers' version
- Examples of use including step-by-step guides
- VO schools for teachers and activities in the classroom

Important: feed-back <-> product improvement cycles

# Software tools

Aladin v9.0 Professional version

Aladin v9.0 Educational version

**Professional version**

SURVEY	COLOR	SIZE	OBS ID	RESOL
<input type="checkbox"/> ZMASS	J (IR J)	8.6' x 17.1'	971018W_J10810185	1.1"/
<input type="checkbox"/> ZMASS	K (IR K)	8.6' x 17.1'	971018W_K10810185	1.1"/
<input type="checkbox"/> ZMASS	H (IR H)	8.6' x 17.1'	971018W_H10810185	1.1"/
<input type="checkbox"/> POSSI	0-DSS2 (0.41um)	13.0' x 13.0'	361	1.1"/
<input type="checkbox"/> POSSII	F-DSS2 (0.658um)	13.0' x 13.0'	554	1.1"/
<input type="checkbox"/> POSSII	J-DSS2 (0.491um)	13.0' x 13.0'	554	1.1"/
<input type="checkbox"/> POSSII	N-DSS2 (0.84um)	13.0' x 13.0'	554	1.1"/
<input type="checkbox"/> POSSI	E-DSS1 (0.645um)	14.2' x 14.2'	361	1.7"/
<input type="checkbox"/> POSSI	E-DSS1 (0.645um)	1.7' x 1.7'	361-LOW	6.8"/
<input type="checkbox"/> POSSI	0-DSS2 (0.41um)	6.5' x 6.5'	361-PLATE	24.3"/
<input type="checkbox"/> POSSII	F-DSS2 (0.658um)	6.5' x 6.5'	554-PLATE	24.3"/
<input type="checkbox"/> POSSII	J-DSS2 (0.491um)	6.5' x 6.5'	554-PLATE	24.3"/
<input type="checkbox"/> POSSII	N-DSS2 (0.84um)	6.5' x 6.5'	554-PLATE	24.3"/
<input type="checkbox"/> POSSI	E-DSS1 (0.645um)	6.7' x 6.7'	361-PLATE	27.2"/
<input type="checkbox"/> IRAS-IRIS	12MU (12.0um)	12.5' x 12.5'	I278B1H0	1.5"/
<input type="checkbox"/> IRAS-IRIS	25MU (25.0um)	12.5' x 12.5'	I278B2H0	1.5"/
<input type="checkbox"/> IRAS-IRIS	60MU (60.0um)	12.5' x 12.5'	I278B3H0	1.5"/
<input type="checkbox"/> IRAS-IRIS	100MU (100.0um)	12.5' x 12.5'	I278B4H0	1.5"/

**Educational version**

Fill in all these fields and press the SUBMIT button

Target (ICRS, name)

Radius

- ☐ Peering into the Heart of the Crab Nebula 1.7' x 1.9'
- ☐ Combined X-Ray and Optical Images of the Crab Nebula
- ☐ A Giant Hubble Mosaic of the Crab Nebula 6.5' x 6.5'
- ☐ Crab Nebula: a Dead Star Creates Celestial Havoc 8.2'



# Examples of Use



## DISTANCE TO THE CRAB NEBULA

G. Iafrate, M. Ramella  
INAF - Astronomical Observatory of Trieste

Information and contacts: <http://vo-for-education.oats.inaf.it> - [iafrate@oats.inaf.it](mailto:iafrate@oats.inaf.it)

Within this use case you learn about supernovae, exploding or exploded stars. In particular you will use information on the Crab Nebula (the 1054 AD supernova registered by Chinese astronomers) to derive its distance: an example of how some very important information may be gained from very simple arguments and geometry.

If used in the classroom this use case requires a very basic knowledge of the relation between angles and sides of triangles. If used in more advanced classes it may be a good demonstration of the power of trigonometry.

### 1 Introduction

The Crab Nebula (M1) is a supernova remnant observable in the constellation of Taurus. The bright supernova "SN1054" that originated the remnant was recorded by Chinese and Arab astronomers in 1054 A.D.

The fact we know the year of the explosion allow us to compute the expansion rate of the gas shell, and then, by comparison between angular and real dimensions of the nebula, obtain its distance.

### 2 The Crab Nebula

In visible light, the Crab Nebula consists of a oval-shaped mass of filaments that

are the remnants of the progenitor star (fig. 1).



Fig. 1: Optical image of the Crab Nebula.

At the center of the nebula lies the Crab Pulsar, a rotating neutron star, which

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edit -> user preferences -> profile -> undergraduate.

Restart Aladin in order to validate the new configuration.  
Open the server selector window:

File -> Load astronomical image  
-> Aladin image server

In the field "target" enter "M1" and press "submit". The list of available images appears (fig. 2): look at the dates of the images and load in Aladin the most recent one (taken in 1998).  
We use this Crab Nebula image in the next step, when we will compute its projected angular size.

Now we need only to know the year the image has been taken. We calculate the time passed since the explosion (1054):

$$(1998 - 1054) \text{ yr} = 944 \text{ yr} = 2.97 \cdot 10^{10} \text{ s.}$$

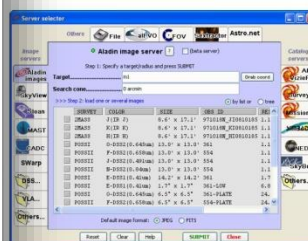


Fig 2: The server selector window with the list of available image.

We multiply this time by the velocity and obtain the linear size (the radius) of the nebula:

$$R = 2.97 \cdot 10^{10} \text{ s} \cdot 1500 \text{ km/s} = 4.46 \cdot 10^{13} \text{ km.}$$

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### 5 Angular size of the nebula

In order to compute the angular size of the nebula we use the tool "distance vector" from the center of the nebula to the outermost visible part.

The outer parts of the nebula are faint, so we adjust the distribution by increasing the contrast.

The center of the nebula marks the pulsar (marked on the image). The distance vector starts from the center and ends in the farthest region of the nebula (probably in the outermost part of the image).

The modulus of the projected distance vector ranges between 2.8'. In the case of fig. 3 it is

$$r = 2.66'.$$

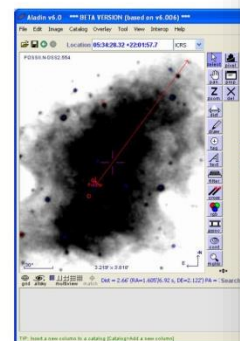


Fig. 3: the distance vector for computing the angular size of the nebula

### 6 Distance to the Crab Nebula

We now have both the linear and the angular size of the nebula: by comparing them we can compute its distance from us.

In order to obtain the distance in parsec we have to express the sizes in the proper units: the linear size in parsec and the angular size in radians.

$$1 \text{ pc} = 3.085 \cdot 10^{16} \text{ m}$$

$$R = 4.46 \cdot 10^{13} \text{ km} = 4.46 \cdot 10^{16} \text{ m} = 1.44 \text{ pc.}$$

Then

$$1 \text{ rad} = 206264''$$

$$r = 2.66' = 159.6'' = 7.73 \cdot 10^{-4} \text{ rad.}$$

We finally compute the distance to the Crab nebula:

$$d = R / r = 1.44 / 7.73 \cdot 10^{-4} = 1860 \text{ pc} = 1.86 \text{ kpc.}$$

The correct value of the distance to the Crab Nebula is about 2 kpc (6500 light years), very close to the value obtained with our simple analysis. In particular our value is a little low because of the approximations of our procedure.

### 7 Hubble Space Telescope images of the Crab Nebula

Aladin can access the archive of the Hubble Space Telescope and load its amazing images.

In order to load the images of the Crab Nebula open the server selector, then in the left column select "Hubble press release image", in the field "target" enter "M1" and press "submit".

Our project depends on your support. If you found our material useful, we kindly ask you to acknowledge it in your publications, or to write us an email ([iafrate@oats.inaf.it](mailto:iafrate@oats.inaf.it)), or like it on our Facebook page ([www.facebook.com/VOedu](https://www.facebook.com/VOedu)). Thanks!

The list of available images (fig. 4).



Fig. 4: Images of the Crab Nebula from the Hubble Space Telescope

For example, if you want to load the image of the Crab Nebula in X-ray and optical images (fig. 5).



Fig. 5: Combined X-Rays and Optical images of the Crab Nebula

By loading "A Giant Hubble Image of the Crab Nebula", you can see the image of the entire nebula (fig. 6).



# Teachers and students



# VO 4 Edu on a global scale

The International Virtual Observatory Alliance (IVOA) establishes the

Edu Interest Group

based on the VO 4 Edu experience (2013)

# IVOA and the Edu IG

Long term goal:

widest global distribution of VO tools, data and practices in support of astronomy teaching in schools and universities



# IVOA and the Edu IG

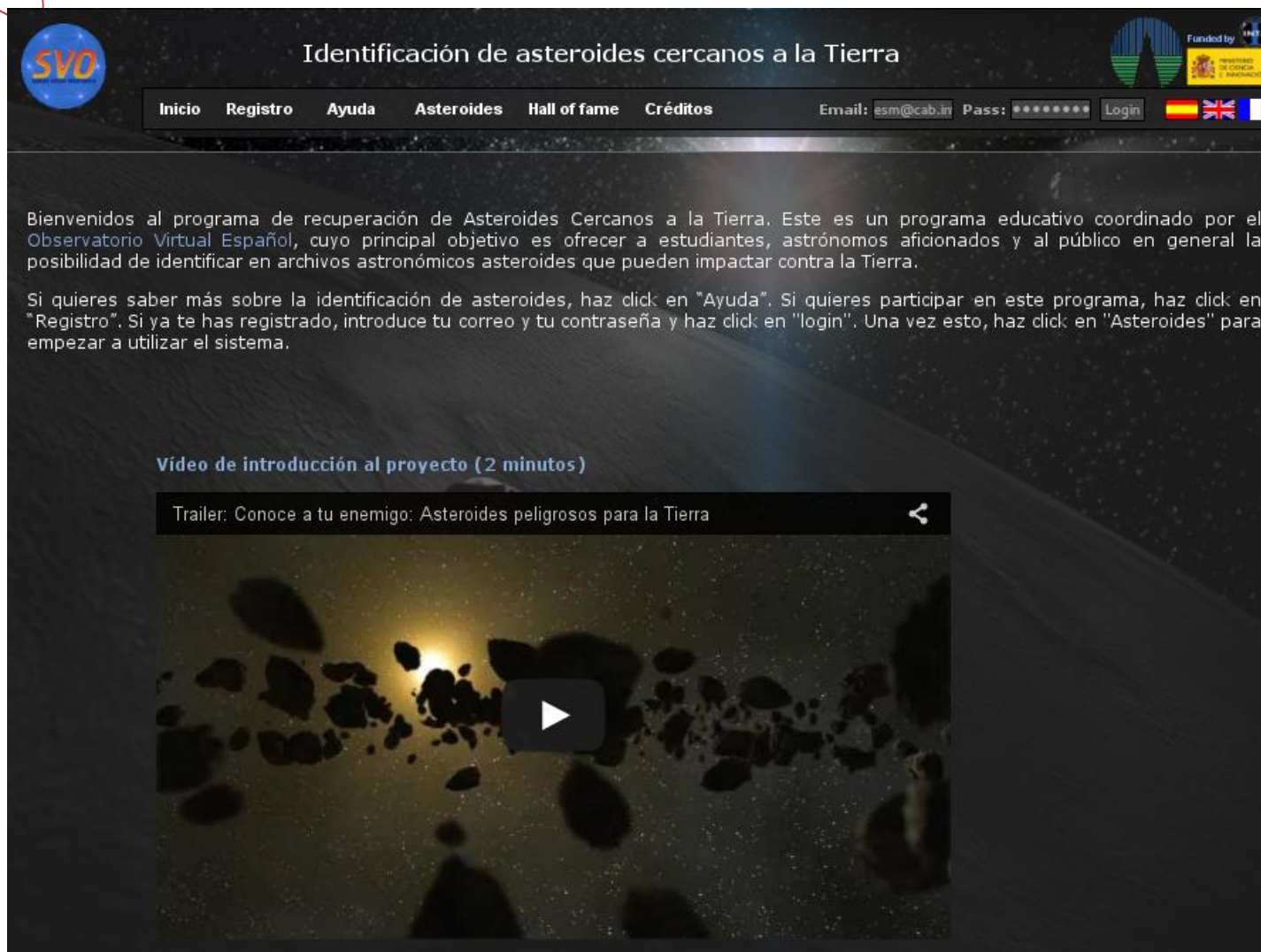
## From the Interest Group's Rationale (2013):

- Astronomy is undergoing major transformations with large investment into few cutting edge instruments with extreme technical specifications and performances.
- A risk of “big science”: astronomy may become too remote from the public.
- It is of the utmost importance for astronomy to develop strong and extended roots within the society. VO is a most effective resource with its excellent educational tools and knowledge base, deriving directly from professional astronomy.

# Future of VO 4 Edu

- Continue development, updating and diffusion
- Systematic approach to translations

and: VO for citizen science projects



The screenshot shows the Asterics website interface. At the top left is the SVO logo. The main title is "Identificación de asteroides cercanos a la Tierra". Below the title is a navigation bar with links: Inicio, Registro, Ayuda, Asteroides, Hall of fame, and Créditos. To the right of the navigation bar are input fields for Email (esm@cab.int) and Pass (masked with dots), a Login button, and flags for Spain, the UK, and France. Below the navigation bar is a welcome message in Spanish: "Bienvenidos al programa de recuperación de Asteroides Cercanos a la Tierra. Este es un programa educativo coordinado por el Observatorio Virtual Español, cuyo principal objetivo es ofrecer a estudiantes, astrónomos aficionados y al público en general la posibilidad de identificar en archivos astronómicos asteroides que pueden impactar contra la Tierra." Below this is a paragraph explaining the program: "Si quieres saber más sobre la identificación de asteroides, haz click en 'Ayuda'. Si quieres participar en este programa, haz click en 'Registro'. Si ya te has registrado, introduce tu correo y tu contraseña y haz click en 'login'. Una vez esto, haz click en 'Asteroides' para empezar a utilizar el sistema." Below the text is a video player with the title "Vídeo de introducción al proyecto (2 minutos)" and a subtitle "Trailer: Conoce a tu enemigo: Asteroides peligrosos para la Tierra". The video player shows a scene with many asteroids in space, with a bright sun in the background. A large play button is centered over the video.

<http://www.laeff.cab.inta-csic.es/projects/near>

Astron. Nachr. / AN 335, No. 2, 142 – 149 (2014) / DOI 10.1002/asna.201311888

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## Precovery of near-Earth asteroids by a citizen-science project of the Spanish Virtual Observatory

E. Solano<sup>1,2,\*</sup>, C. Rodrigo<sup>1,2</sup>, R. Pulido<sup>1,2</sup>, and B. Carry<sup>3</sup>



Icarus

Volume 268, April 2016, Pages 340-354



Spectral properties of near-Earth and Mars-crossing asteroids using Sloan photometry

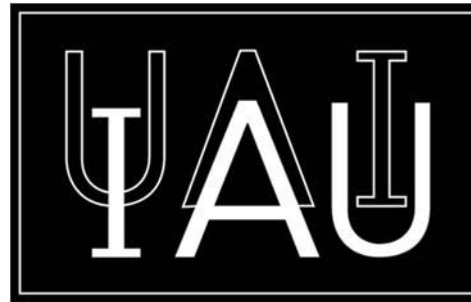
B. Carry <sup>a, b</sup> ✉, E. Solano <sup>c, d</sup>, S. Eggl <sup>a</sup>, F.E. DeMeo <sup>e, f</sup>



# Future of VO 4 Edu

Last but not least,

Now VO is in IAU's DEPO WG



IAU Inter-Commission B2-C1-C2 WG

## Data Driven Astronomy Education and Public Outreach

Chenzhou CUI, Chair

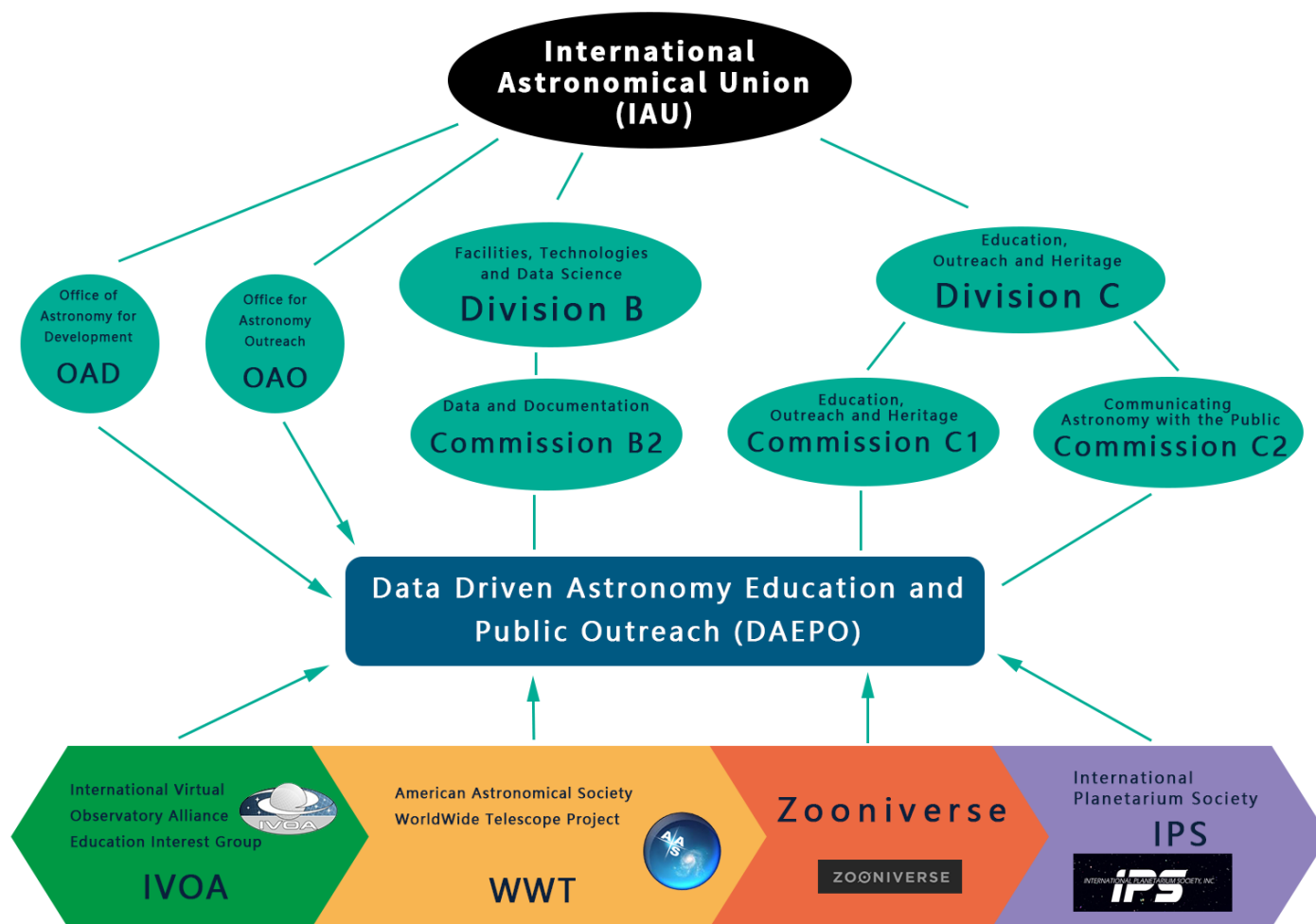
Author: Chenzhou CUI

11/21/2017

Massimo Ramella, UN/Italy Workshop on  
the Open Universe Initiative/ Wien

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# DAEPO Ecosystem



Author: Chenzhou CUI

# Conclusion

EPO is an ethical requirement in a society based  
on consensus  
and  
a lot has been accomplished  
but  
the road from the telescope to the classroom is  
all but short, downhill and well paved.