

Identification of near-Earth asteroids in astronomical archives. A citizen-science project of the Spanish Virtual Observatory.

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The Virtual Observatory (VO)

- **Goal:** Efficient access and analysis of the information hosted in astronomical archives and services.



The Spanish Virtual Observatory



Carlos Rodrigo



Enrique Solano



Miriam Aberasturi



Almudena Velasco



Mauro López



Alba Aller



J. Manuel Alacid

Francisco Jiménez

The Spanish Virtual Observatory

<http://svo.cab.inta-csic.es>

@ObsVirtEsp



Spanish Virtual Observatory

Funded



Home Help Desk

The SVO



The Spanish Virtual Observatory (SVO) officially started in June 2004. Its purpose is to coordinate the VO activities at national level and act as a contact point for the other VO initiatives. The SVO core team is hosted at Centro de Astrobiología (INTA-CSIC).

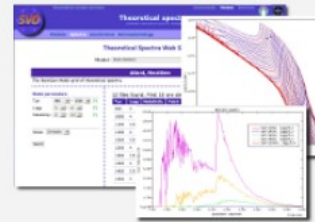
- SVO participants
- VO FAQs

The CAB Scientific Data Centre



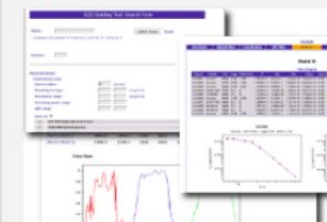
- Calar Alto
- COROT
- DUNES
- DSS-63
- GASPS
- GAUDI
- GTC
- INES
- OMC
- Protostars
- X-exoplanets
- Other archives in the SVO Network

Theoretical Data Server



- Stellar Spectra theoretical models
- Evolutionary Synthesis Models
- Isochrones and evolutionary tracks
- Asteroseismology

Services



- VOSA
- VOSED
- TESELA
- Filter Profile Service

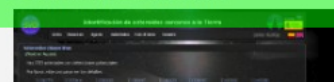
VO Science



Data Mining



Education & Outreach



Miscellanea



Citizen-science project

- ✓ Scientific research conducted, in whole or in part, by amateur or non-professional scientists.





The screenshot shows the Audubon website's navigation bar with links for BIRDS, CONSERVATION, EDUCATION, GET OUTSIDE, and ABOUT US. Below the navigation bar, there is a breadcrumb trail for 'Home / Birds' and a row of social media sharing buttons for Share, Like (4.6k), Tweet (517), LinkedIn, YouTube, and Pinterest, along with print and email icons. The main heading is 'Christmas Bird Count'. The text below reads: 'The 113th Christmas Bird Count took place from December 14, 2012 through January 5, 2013. See print and audio news coverage of the 113th Christmas Bird Count via [Audubon in the News](#).' Below this, it says 'Big News!' and 'The CBC is now FREE!'. A photograph of a bird branch with red berries is partially visible on the right side of the page.



Citizen-science project

CLASSIFY SCIENCE STORY **GALAXY ZOO** ASTRONOMERS DISCUSS PROFILE



Classify   [Help](#) [Restart](#)

SHAPE
Is the galaxy simply smooth and rounded, with no sign of a disk?

 Smooth  Features or disk  Star or artifact

Near-Earth asteroids

ASTRONOMÍA | 2012 DA14 fue descubierto en La Sagra (Granada)

El asteroide que más se ha aproximado a la Tierra sin colisionar

VIDEO FOTO

2013-Feb-15 21:18:10 UTC

RUSIA | Por la rotura de cristales provocada por el impacto

Más de 900 heridos tras la caída de un meteorito en los Urales

VIDEO FOTO



Near-Earth asteroids



Barringer

2008 TC3



Near-Earth asteroids



NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

+ View the NASA Portal



Near Earth Object Program

UPCOMING CLOSE APPROACHES TO EARTH

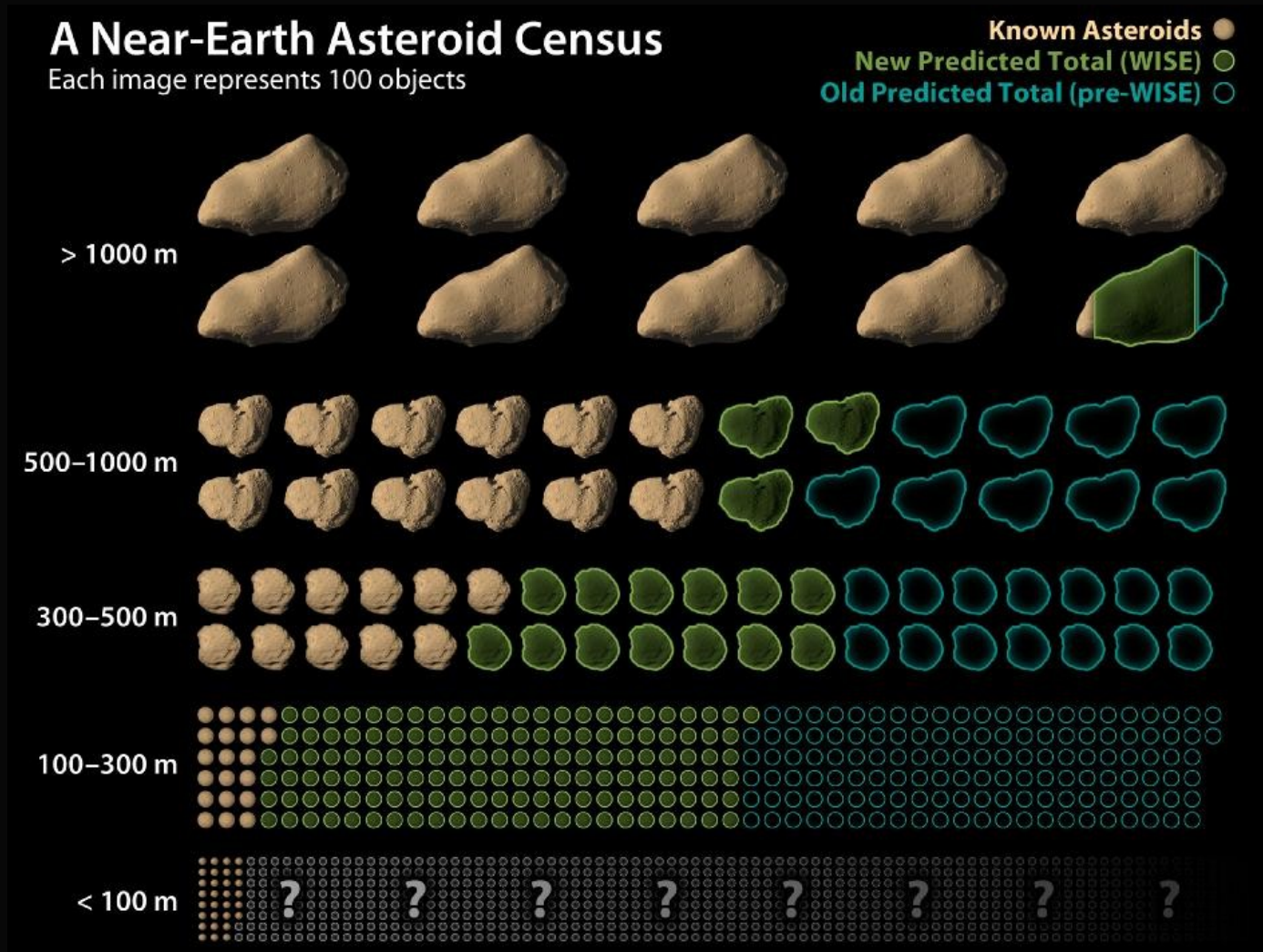
1 AU = ~150 million kilometers

1 LD = Lunar Distance = ~384,000 kilometers

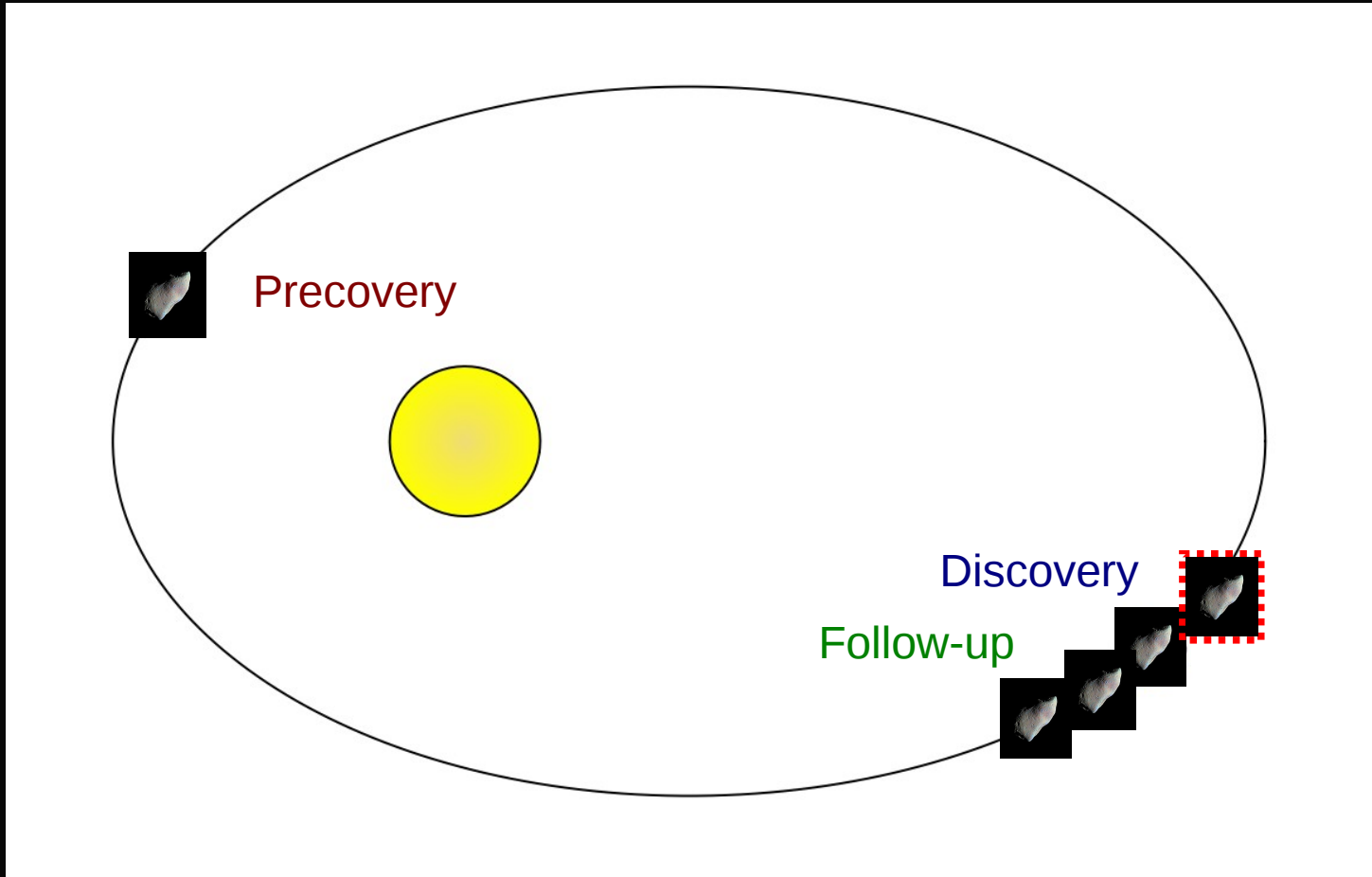
Object Name	Close Approach Date	CA Distance* (AU)	CA Distance* (LD)	Estimated Diameter**	H (mag)	Relative Velocity (km/s)
(2013 LC7)	2013-Jun-16	0.1271	49.4	350 m - 790 m	19.4	35.66
(2013 JR28)	2013-Jun-18	0.0349	13.6	130 m - 290 m	21.6	16.99
(2011 KR12)	2013-Jun-18	0.1670	65.0	140 m - 310 m	21.4	8.46
340666 (2006 RO36)	2013-Jun-18	0.1823	70.9	740 m - 1.7 km	17.8	12.76
(2013 KL6)	2013-Jun-20	0.0346	13.5	38 m - 85 m	24.2	10.57
(2010 LL68)	2013-Jun-21	0.1826	71.1	77 m - 170 m	22.7	8.09
(2013 LC2)	2013-Jun-21	0.0970	37.7	97 m - 220 m	22.2	8.26
164202 (2004 EW)	2013-Jun-23	0.1840	71.6	190 m - 420 m	20.8	5.09
354952 (2006 FJ9)	2013-Jun-24	0.1992	77.5	370 m - 840 m	19.3	4.63
(2011 DL19)	2013-Jun-25	0.1828	71.1	430 m - 960 m	18.9	19.82
(2013 LE1)	2013-Jun-25	0.1287	50.1	80 m - 180 m	22.6	11.26

VO – CS – NEAs – Precov. - The project

Near-Earth asteroids



Precovery



Precovery

(99942) ApophisE

Distance: 14,008 km

Radius: 420,00 m

Apparent diameter: 3° 20' 10,3"

2029 04 14 09:37:31 UTC

Time stopped



Speed: 0,00000 m/s

Follow (99942), ApophisE

FOV: 7° 15' 3,5" (3,56x)

Precovery



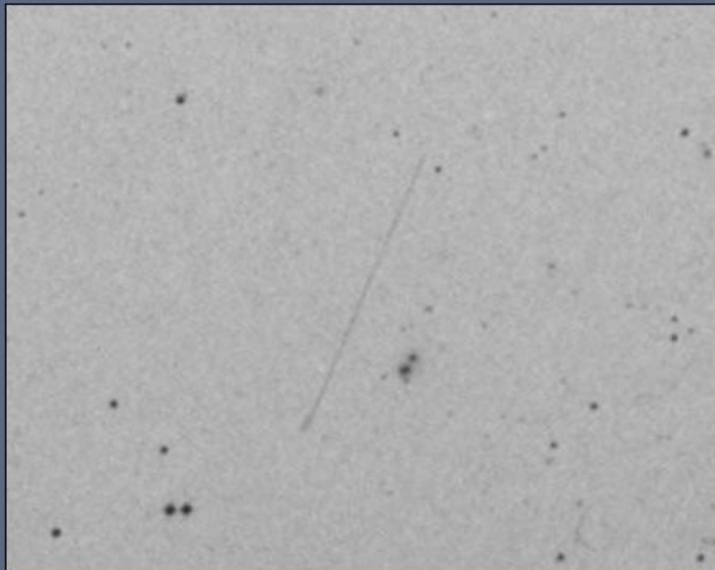
Siding
Spring
Survey



AANEAS

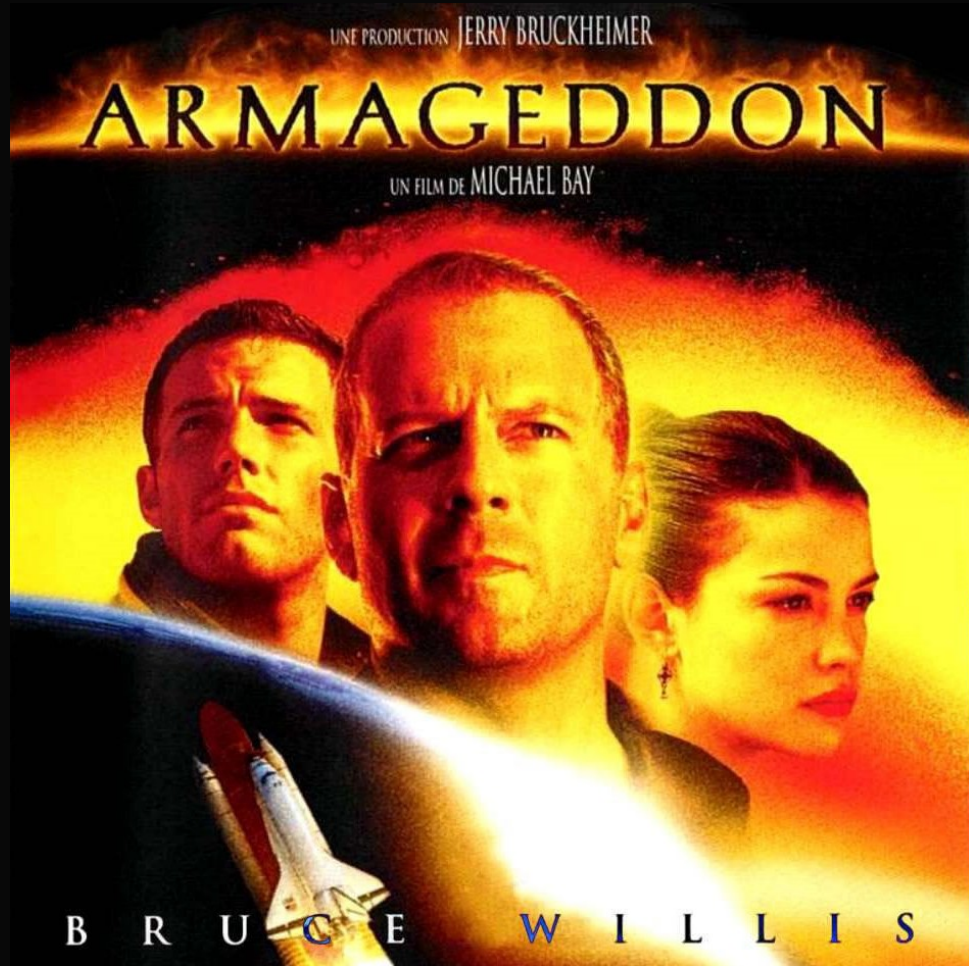


(6318) Cronkite
precovery image,
1982 Dec 5
On original 90min
exposure, trail
was 3.5mm long.
(c) SERC 1982



VO – CS – NEAs – **Precov.** - The project

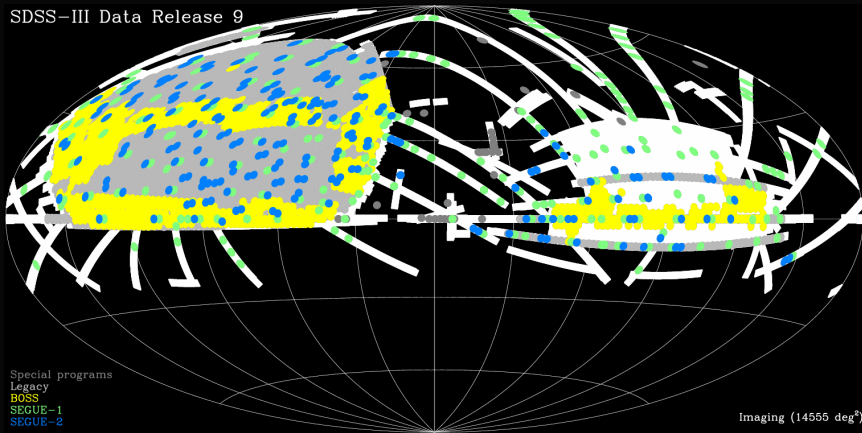
The citizen-science project



The citizen-science project



Prov.	Des.	q	Q	EMoid	H	Epoch	M
2013	NG6	1.275	2.938	0.25905	22.3	20130418	340.7
2013	NU	1.289	3.367	0.27284	21.3	20130418	330.2
2013	NK	1.273	3.530	0.26889	21.4	20130418	324.4
2013	MP11	1.251	3.142	0.24031	21.8	20130418	341.4
2013	MV10	1.137	2.817	0.14263	21.8	20130418	350.0
2013	MR6	1.226	4.186	0.28077	18.8	20130418	324.6
2013	MZ5	1.278	1.826	0.46072	20.2	20130418	258.9
2013	MX5	1.252	3.292	0.25652	18.9	20130418	336.1






VO – CS – NEAs – Precov. - The project

- RA/DEC min/max
- Obs. Time

The citizen-science project

NEODyS-2
Near Earth Objects - Dynamic Site

Sponsored by   

Home **Objects** Observatories Search Risk page NEA elements Related sites Info & Credits

(433) Eros [EPHEMERIDES](#) [Help]

[Download ASCII file](#)

Date	Hour (UTC)	Equatorial coordinates			Mag	Alt (deg)	Airmass	Sun elev.	SoLEl (deg)	LunEl (deg)	Phase (deg)	Glat (deg)
		RA h m s	DEC d ' "									
6 Jul 2013	9.533	4 11 53.152	+28 34 13.76	13.8	0.0	INF	NaN	38.6	20.2	27.8	-16.4	
7 Jul 2013	9.533	4 15 29.441	+28 42 51.56	13.8	0.0	INF	NaN	38.8	30.4	28.0	-15.8	
8 Jul 2013	9.533	4 19 6.855	+28 51 10.78	13.8	0.0	INF	NaN	38.9	41.0	28.2	-15.1	
9 Jul 2013	9.533	4 22 45.379	+28 59 11.05	13.8	0.0	INF	NaN	39.0	51.8	28.3	-14.4	
10 Jul 2013	9.533	4 26 24.998	+29 6 52.00	13.8	0.0	INF	NaN	39.2	62.8	28.5	-13.8	
11 Jul 2013	9.533	4 30 5.698	+29 14 13.29	13.7	0.0	INF	NaN	39.3	73.9	28.7	-13.1	

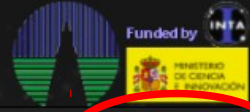
- ✓ Out of image
- ✓ Too faint
- ✓ Candidate

The citizen-science project

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



Identificación de asteroides cercanos a la Tierra



[Inicio](#) [Registro](#) [Ayuda](#) [Asteroides](#) [Hall of fame](#) [Créditos](#)

Email: Pass: [Login](#)



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.

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.

[Vídeo de introducción al proyecto \(2 minutos\)](#)

[Resultado más destacados](#)

[Novedades](#)

The citizen-science project





Identificación de asteroides cercanos a la Tierra



Inicio Registro Resumen Ayuda **Asteroides** Astero-Dance Hall of fame Créditos SVO

Usuario

Enrique Solano  

Asteroides disponibles

(Mostrar Ayuda)

Hay 27 asteroides con detecciones potenciales

Por favor, elije uno para ver los detalles.

13 asteroides de tipo Amor (?)

142040 2006KL21	162196 2006QS	189973 2006QW89	1995SD1 2007HZ	1999EE5 2012MP	1999EE5	2000JA3	2006KF89
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12 asteroides de tipo Apolo (?)

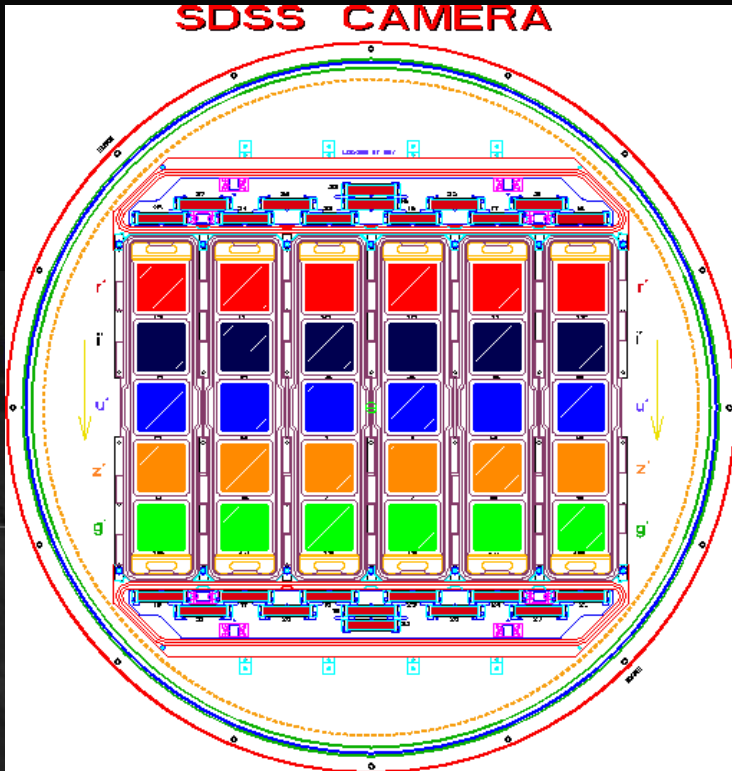
143992 2003DN4	152964 2003WL25	153311 2004TB18	153814 2012LT7	154715	164184	177614	2002XC91
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2 asteroides de tipo Atón (?)

2007EP88	2008EE
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The citizen-science project

SDSS CAMERA



Asteroides cercanos a la Tierra



Asteroides Astero-Dance Hall of fame Créditos SVO

Enrique Solano

2012MP

Comprobación visual

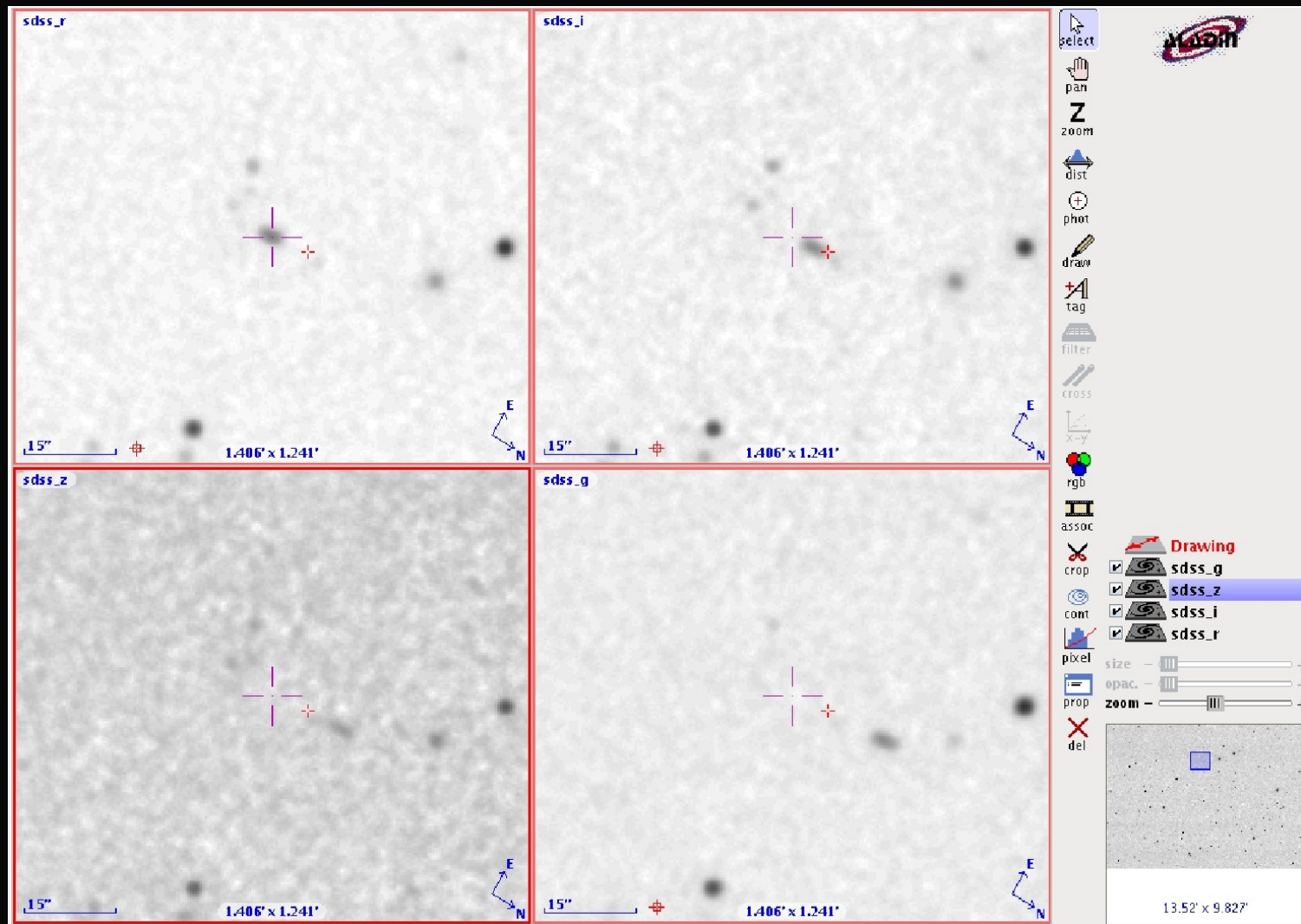
mag	RA/DEC	Estatus	Com
-----	--------	---------	-----

sdss_r	55153.15539669	355.61941	30.41233	21.75				
sdss_i	55153.15622596	355.61971	30.41202	21.75				
sdss_u	55153.15705522	355.62031	30.41139	21.75				
sdss_z	55153.1578844901	355.62061	30.41108	21.75				
sdss_g	55153.15871375	355.62091	30.41077	21.75				

[Ver en Aladin](#)
(script)

Guardar Datos

The citizen-science project



The citizen-science project



SVO Spanish Virtual Observatory

Potentially Hazardous Asteroids Precovery

Funded by INTA and Ministerio de Ciencia e Innovación

Inicio Registro Ayuda Asteroides Hall of fame SVO Usuario Carlos Rodrigo  

2005FE3

(Mostrar Ayuda)

Hay 1 conjunto de observaciones con detecciones potenciales de 2005FE3

Banda	Posición esperada				Comprobación visual	
	MJD	RA	DEC	mag	RA/DEC	Estatus
sdss_r	53389.52256453	175.43906	24.54815	20.96	175.43764 +24.54747	Confirmado
sdss_i	53389.5233938	175.43935	24.54833	20.96	175.43801 +24.54771	Confirmado
sdss_u	53389.52422306	175.43964	24.54852	20.96		Demasiado débil
sdss_g	53389.5258815901	175.4405	24.54908	20.96	175.43896 +24.54838	Confirmado

[Ver en Aladin](#)

Guardar Datos

©Spanish Virtual Observatory(Credits)

The citizen-science project



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- [Also-Read Articles](#) ([Reads History](#))
- [Translate This Page](#)

Title: Minor Planet Observations [645 Apache Point--Sloan Digital Sky Survey]

Authors: [Ivezic, Z.](#); [Survey, S.](#); [Galvez Ranera, E.](#); [de Madrid, P.](#); [Solano, E.](#); [Bustabad Alonso, L.](#); [Carruba, J.](#); [Cuadrado Garcia, J.](#); [de La Osa Lopez, J. M.](#); [Gil Rey, J.](#); [Gutierrez Bulnes, L.](#); [Izarra Cala, J.](#); [Pascual Gutierrez, J. I.](#); [Rodriguez Perez, D.](#); [Rodriguez Pumarada, C.](#); [Vazquez, J.](#); [Antoranz, J. I.](#); [Muñoz Barros, F. D.](#); [Rojas Garcia, C.](#); [Romero Dueñas, J. L.](#); [Serrano Guinot, J. P.](#); [Tapiolazo, J. I.](#); [Gomez Sanchez-Tirado, M. A.](#); [Leal, G.](#); [Sixto Perez, A. J.](#); [Valenzuela, J.](#); [Sala Puig, C.](#); [Barral, J. I.](#)

Publication: Minor Planet Circular 75600, 1 (2011)

Publication Date: 08/2011

Origin: MPC

Bibliographic Code: [2011MPC..75600...1I](#)

Results



Identificación de asteroides cercanos a la Tierra

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[Usuario](#)

25299 José Ramón Vidal Blanco

16344 Fabio Arias Arias

15961 Alvaro Manchado

15641 José Luis Moreno Díaz

14450 Andres F. Montoya H.

10202 Valmir Martins de Morais

9899 Jose Vazquez

9133 Hernando Pachon Sanchez

8936 ANDRES NORTES NOLASCO

8199 Encarni Gomez Fernandez

7311 Tomás Vázquez Chiscano

Ver resumen hasta el - -

Número de usuarios registrados: 3472

Número de usuarios que han hecho medidas: 461

Número de medidas realizadas: 327193

Número de objetos comprobados: 3038

Número de parejas objeto/imagen distintas comprobadas: 30801

Objetos para los que se han publicado medidas en el MPC: 633

Número de medidas publicadas en el MPC: 2767

Results

Table 1 Summary of the measurements reported to MPC. (1): Extended arc beyond last observation reported by the MPC. (2): New intermediate positions. (3): New observations for single opposition asteroids.

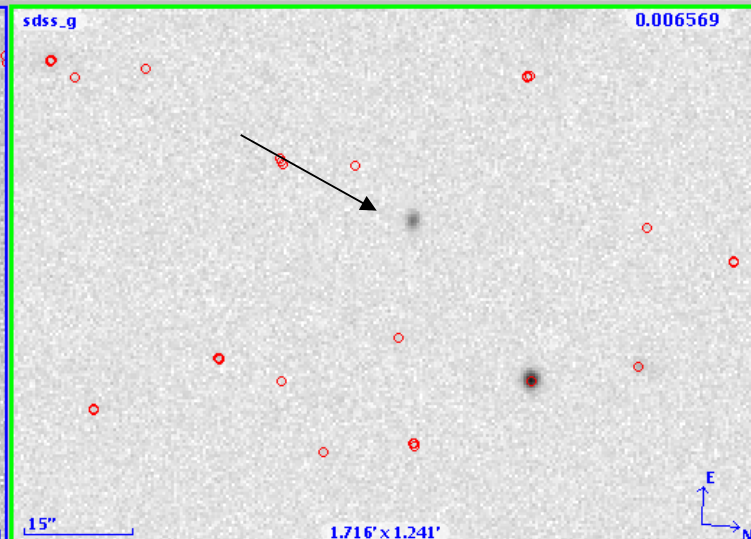
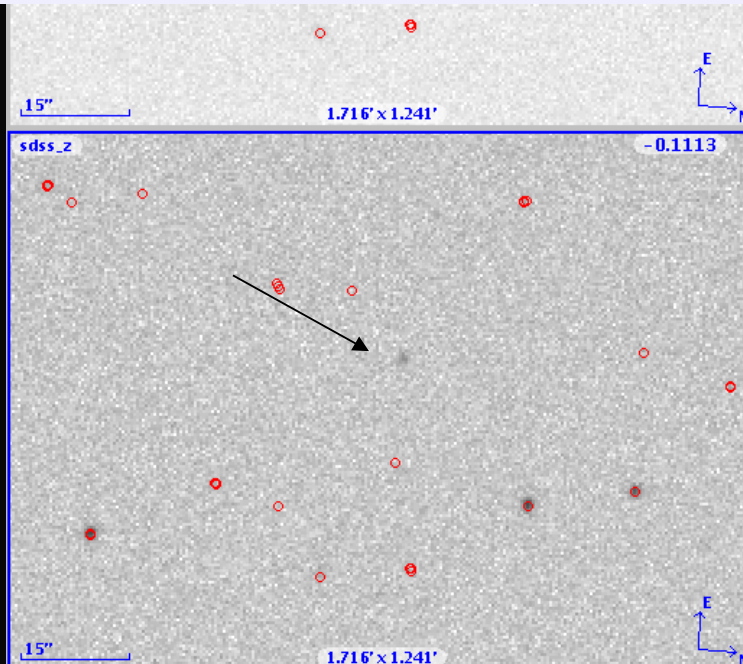
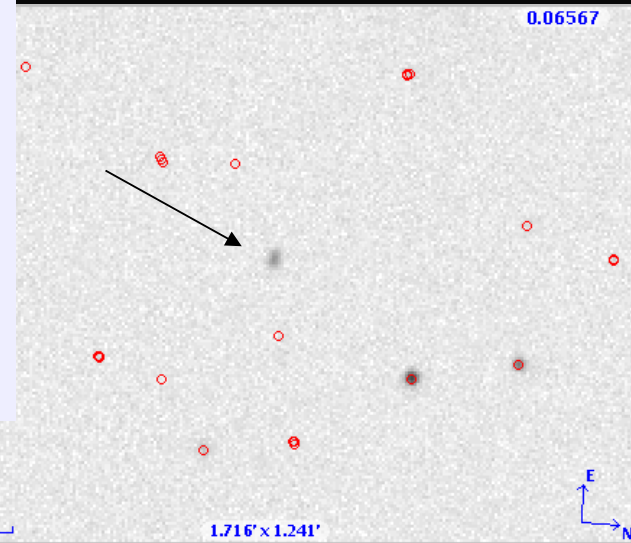
	PHA	Apollo	Aten	Amor	Total
Precovery	24	42	6	58	130
Extended ⁽¹⁾	4	13	—	12	29
Intermediate ⁽²⁾	3	6	—	15	24
Single ⁽³⁾	11	15	1	29	56
Total	42	76	7	114	239

Sep 2012.

- ✓ NEAs not detected by the SDSS pipeline

Results

```
WHERE (  
  (objFlags & (OBJECT_SATUR | OBJECT_BRIGHT | OBJECT_BLENDED)) == 0  
  &&  
  (objFlags & OBJECT_DEBLENDED_AS_MOVING) > 0  
  &&  
  (objc_type == 6)  
  &&  
  (psfCounts[2] > 14.5) && (psfCounts[2] < 21.5)  
  &&  
  (rowv*rowv + colv*colv > 0.0025)  
  &&  
  (rowv*rowv + colv*colv < 0.25)  
)
```



Present & future work

✓ **New type of asteroids:** Mars crossers ✓

✓ **New surveys:**

✓ VISTA (VHS) ✓

✓ UKIDSS

The paper

Astron. Nachr. / AN 999, No. 88, 789 – [797](#) (2006) / DOI *please set DOI!*

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

E. Solano^{1,2,*}, C. Rodrigo^{1,2}, R. Pulido^{1,2}, and B. Carry³

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² Spanish Virtual Observatory

³ IMCCE, Observatoire de Paris, UPMC, CNRS, 77 Av. Denfert Rochereau 75014 Paris, France

Received xx Dec 2012, accepted xxxxx

Published online later

Key words Asteroids – astronomical databases: miscellaneous

This article describes a citizen-science project conducted by the Spanish Virtual Observatory (SVO) to improve the orbits of near-Earth asteroids (NEAs) using data from astronomical archives. The list of NEAs maintained at the Minor Planet

Spin-off

✓ Rapid response

SVO
Small Virtual Observatory

Identificación de asteroides cercanos a la Tierra

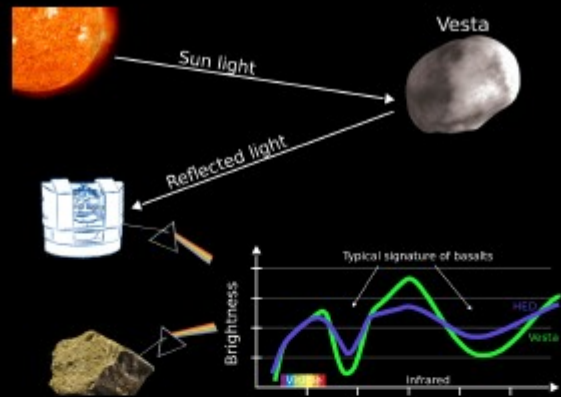
Inicio Registro Resumen Ayuda Asteroides Hall of fame SVO Usuario

Hypatia Control

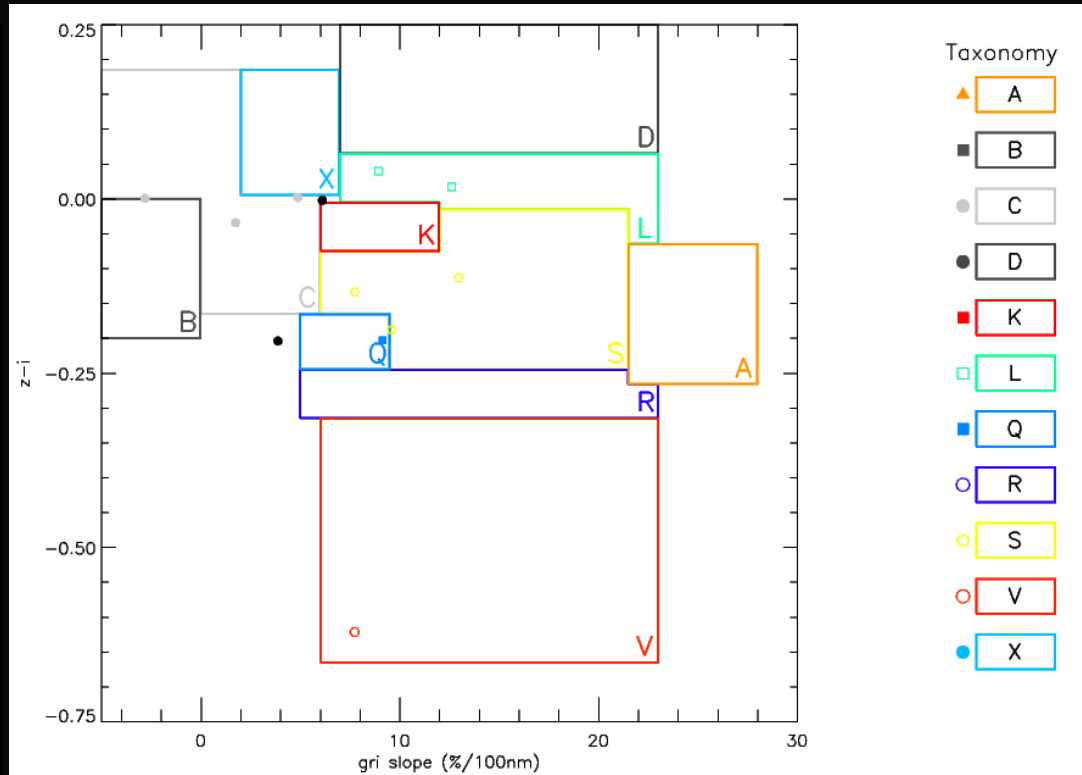
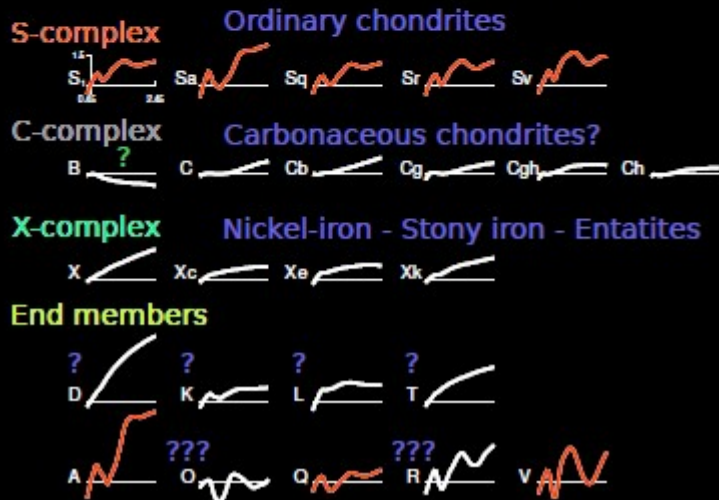
Status	Objects	Logs	Surveys	Risk	CloseAp	Highlight		
Tipo	Process	Status	Start	Last Change	Stop	Logs	Actions	
atira	objects	Ended	2013/06/19 00:15:05	2013/06/19 00:15:08	2013/06/19 00:15:08	20130619	run	
atira	sdss	Ended	2013/06/19 00:25:05	2013/05/19 01:04:04	2013/06/19 00:55:49	20130619	run	
atira	vhs	Ended	2013/06/19 00:25:05	2013/05/19 00:25:07	2013/06/19 00:25:07	20130619	run	
aten	objects	Ended	2013/06/19 00:15:05	2013/06/19 00:20:58	2013/06/19 00:23:46	20130619	run	
aten	sdss	Ended	2013/06/19 00:25:05	2013/06/19 01:15:14	2013/06/19 01:31:55	20130619	run	
aten	vhs	Ended	2013/06/19 00:25:05	2013/06/19 00:30:36	2013/06/19 00:33:39	20130619	run	
amor	objects	Ended	2013/06/19 00:15:05	2013/06/19 00:31:58	2013/06/19 00:34:43	20130619	run	
amor	sdss	Ended	2013/06/19 00:25:05	2013/06/19 01:52:59	2013/06/19 02:05:07	20130619	run	
amor	vhs	Ended	2013/06/19 00:25:05	2013/06/19 00:38:27	2013/06/19 00:41:06	20130619	run	
apollo	objects	Ended	2013/06/19 00:15:05	2013/06/19 00:44:56	2013/06/19 00:44:56	20130619	run	
apollo	sdss	Ended	2013/06/19 00:25:05	2013/06/19 02:13:20	2013/06/19 02:25:01	20130619	run	
apollo	vhs	Ended	2013/06/19 00:25:05	2013/06/19 00:47:55	2013/06/19 00:50:09	20130619	run	
mars	objects	Running	2013/05/14 00:15:05	2013/05/15 12:57:59	---	20130514	stop	
mars	sdss	Ended	2013/06/19 00:25:05	2013/05/16 01:02:36	2013/06/19 00:56:25	20130619	run	

Spin-off

✓ Asteroid taxonomy



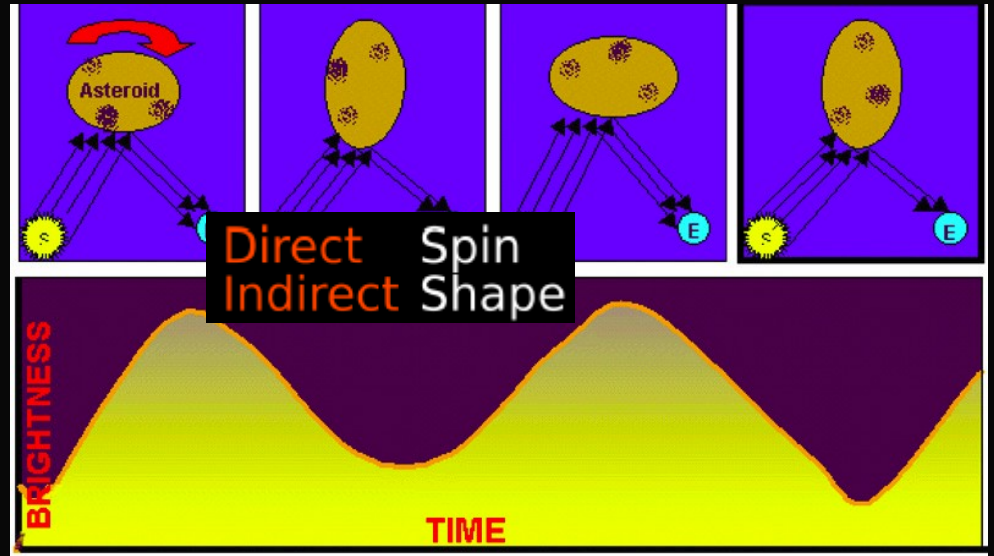
Bus-DeMeo Taxonomy Key



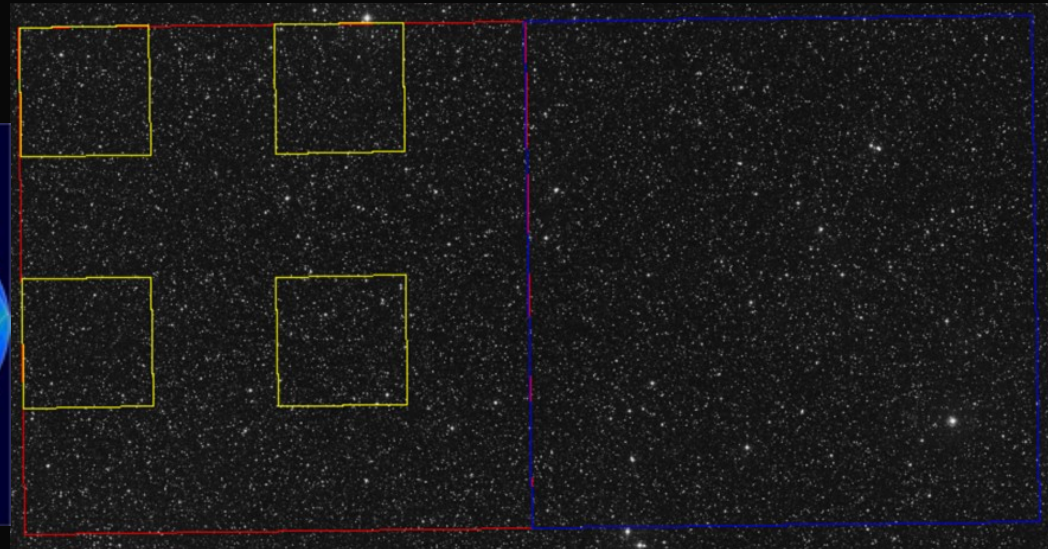
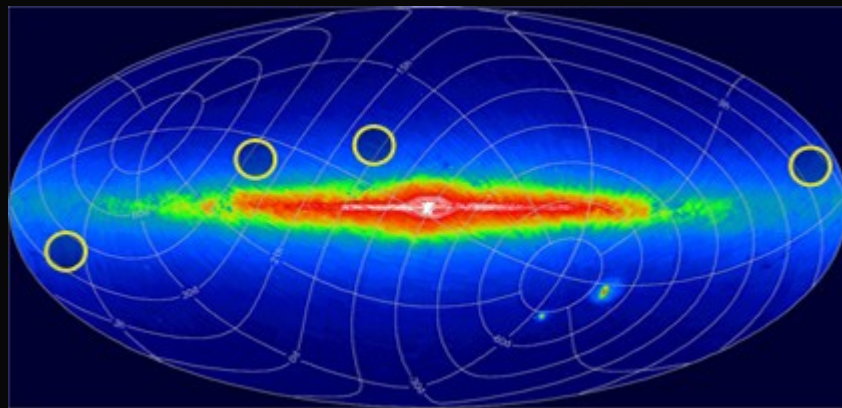
+ IR (UKIDSS, VISTA)

Spin-off

✓ Light curves



The WFCAM Transit Survey



Summary

- ✓ Outreach is important
 - ✓ They pay for your research. It is important to tell society what you do and why it is important.
 - ✓ Contacting young people is the way to ensure the long-term sustainability of Science.
 - ✓ People don't care science → Not true.
- ✓ Archives play a fundamental role in modern astrophysics. → *Science at zero cost.*
- ✓ *VO is THE infrastructure to efficiently extract the knowledge hidden in archives.*