Time Series in the VO

Looking for a Data Model

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Euro-VO DCA workshop: How to publish data into the VO
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Time Series in the VO

The Spanish Virtual Observatory

Aims

- Development of a VO infrastructure in Spain
- Coordination of the activities of the Spanish institutes in the VO framework
- Contact-point for the international VO-projects
- Led by LAEFF / INTA
- Network of almost 100 researches from more than 20 labs/depts

The Funding Bodies

AyA2004-00254
AyA2005-04286 AyA2005-24102E

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

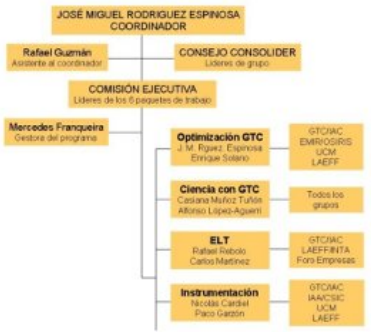
CONSOLIDER - INGENIO GTC

INTA

EURO VO DATA CENTRE ALLIANCE

EURO VO AIDA Astronomical Infrastructure for Data Access

Organigrama Consolider GTC



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EuroVO-DCA Board members

Organisation	Name
CNRS	Françoise Genova (Project Coordinator)
ESA	Martin F. Kessler
ESO	Paolo Padovani
INAF	Fabio Pasian
INTA	Enrique Solano
MPG	Wolfgang Voges
NOVA	Edwin A. Valentijn
LU	Mike Watson

EuroVO-DCA, Work Package 6: Support to data centres from other European countries

Contact person: Enrique Solano (INTA)

WP6 Objectives

- Identification of data centres likely to be interested in publishing their data in the VObs in European countries beyond the partners' countries
- Support to their take-up and implementation of the VObs

WP6 Description of work

- Contacts with European data centre managers
- Identification of their specific needs
- Support to participation to EuroVO Workshops and to implementation, in particular by technical visits
- Gather feedback from data centres

Expected results

- Increased awareness about the VObs framework in the whole European Data Centre Community
- Inclusion of European data centres from other countries in the VObs framework
- Input to the Census of European Data Centres (deliverable D5)

Ground based observations

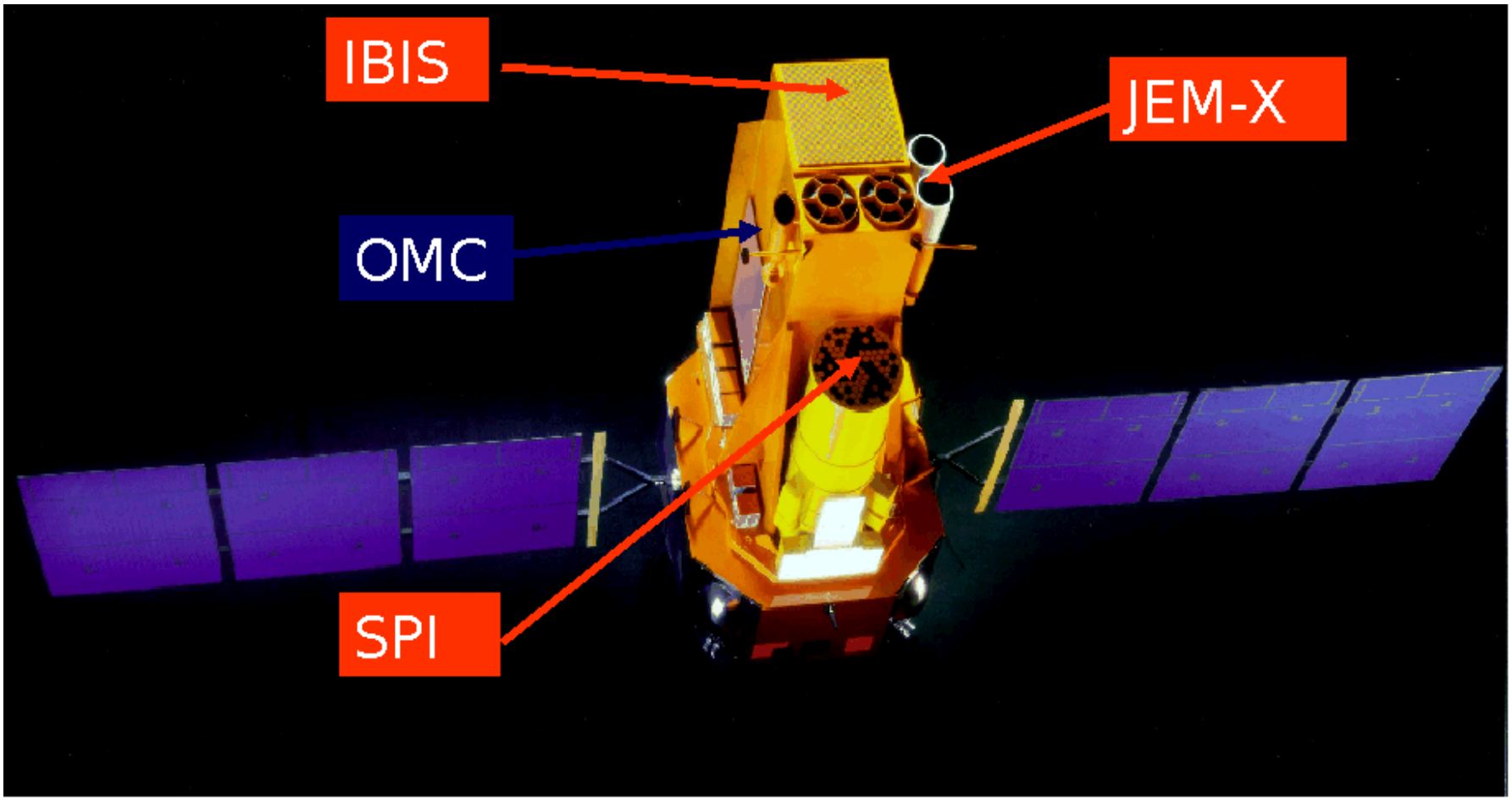
ASAS

- All Sky Automated Survey
- Objective: Photometric monitoring of approx. 10^7 stars brighter than 14 magnitude all over the sky

MACHO

- MAssive Compact Halo Objects
- Light curves in two colors for 8 million stars in the LMC and 10 million in the bulge of the Milky Way

OMC



OMC

- OMC observes the optical emission (V Johnson) from the prime targets of the gamma-ray instruments
- The operation of INTEGRAL from a high orbit allows making continuous observations for several weeks with the only interruption of the radiation belts crossing

First opportunity to make photometry of long duration in the optical simultaneously with those at X and gamma-rays

New challenges

Large-scale photometric monitoring of stars are/will be delivering large numbers of high quality light curves

- COROT (launched on 27 Dec 2006): light curves for up to 60 000 stars with a sampling rate better than 10 minutes during 5 months
- Kepler (foreseen launch: end 2008) >100 000 stars with comparable sampling rate
- GAIA (to be launched in 2011): One billion of stars with about 80 measurements during 5 years for each star

Problem description

- There is not a standard to represent ligth curves!
- It is mandatory to include these data in the VO to grant a productive exploitation of them
- i.e., neither ASAS or MACHO have even a simple form to query data. So we can only make science with them in the old way (very slow)
- We should have the VO tools, standards and software ready for the new missions to come, so they can be adapted from the very beginning

Requirements

- Time series are naturally represented as a data table, so VOTable is the right choice for them.
- Spectrum Data Model is able to describe light curves
- There are UCDs for a lot of light curves concepts (such as time)
- But the Spectrum Data Model is far away to be able to characterize all kind of light curves archives

There is not a model to describe and characterize time series

Is anyone working in this problem?

- Yes
- Related with the EuroVO-DCA project (WP6) there is a colaboration between the SVO and the Konkoly Observatory
- But we don't want an ad-hoc solution
- Ad-hoc solutions = Back to pre-VO age
- So, if there are more people interested, we could join into an IVOA working group

What is a Time Serie?

Definition

- Sequence of numbers collected, often at regular intervals, over a period of time
- Usually Time vs. Flux
- Light curves are a good example
- But, what about phase-folded light curves?
- We must define very clearly what we want to represent with our model

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- But, what about phase-folded light curves?
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Solution based on Spectral Data Model

- We registered the (probably) first time-series catalogue in the VO (for OMC)
- *http://sdc.laeff.inta.es/omc/jsp/ssap.jsp*
- We used a modified version of the Spectral Data Model
- But we need to make something that serves as a guideline to anyone
- And we have observed that the Spectral Data Model is not good for some light curves characteristics

Data Model Idea

- A very similar data model: Spectrum
- Can we define Time Series with it?
- It has defined Time and Flux Axis
- It is widely used
- At least, it is a perfect starting point

Problems detected

There are several problems hard to define with the Spectral Data Model:

- Photometric data reduction
  - Absolute photometry
  - Relative photometry
- For variable star photometry
  - Differential magnitudes
  - Truncated time data
  - Phases: derivated data, not primaray observations
  - Observed minus Calculated
- Adding transmission curve and the zero point
- Photometric system characterization

Example

```
<?xml version="1.0" encoding="UTF-8" standalone="yes" ?>
<VOTABLE version="1.1"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:noNamespaceSchemaLocation="xmlns:http://www.voa.net/xml/VOTable/VOTable-1.1.xsd"
      xmlns:spec="http://www.ivoa.net/ml/SpectrumModel/v1.01"
      xmlns:stc="http://www.ivoa.net/xml/STC/v1.3"
      xmlns="http://www.ivoa.net/xml/VOTable/v1.1">

<RESOURCE name="IBVS 2012-t4">
      <DESCRIPTION>
            Electronic data file for IBVS 2012 ....
      </DESCRIPTION>

      <TABLE name="Observations">
            <GROUP ID="Target">
                  <DESCRIPTION>
                        The group "Target" contains the variable star being observed (HD
214791) and the comparison star (HD 215156).
                  </DESCRIPTION>
                  <PARAM name="Target" utype="spec:Target.Name" ucd="meta.id;src"
datatype="char" arraysize="*" value="HD 214791"/>
                  <PARAM name="comparisonStar" ucd="meta.id.assoc" datatype="char"
arraysize="*" value="SAO 231267">
            </GROUP>

            <FIELD ID="col1" ucd="time.epoch" unit="d" datatype="double" width="9"
precision="4" ref="HJD-24400000" utype="Spec:Data.TimeAxis.Value">
                  <DESCRIPTION> Observation date </DESCRIPTION>
```

Example

```
<FIELD ID="col2" name="Phase" ucd="time.phase" datatype="double" width="6"
precision="4" utype="Spec:?">
<DESCRIPTION> Phase value, assuming P=2.9684994d and T0=HJD 2430132.327
</DESCRIPTION>
</FIELD>
<FIELD ID="col3" ucd="em.opt.V;arith.diff" name="DV" unit="mag"
datatype="double" width="5" precision="3" utype="Spec:Data.FluxAxis.Value">
<DESCRIPTION> Differential V (variable -comparison) </DESCRIPTION>
</FIELD>
<FIELD ID="col4" ucd="em.opt.B;arith.diff" name="DB" unit="mag"
datatype="double" width="5" precision="3" utype="Spec:Data.FluxAxis.Value">
<DESCRIPTION> Differential B (variable -comparison) </DESCRIPTION>
</FIELD>
<FIELD ID="col5" ucd="em.opt.U;arith.diff" name="DU" unit="mag"
datatype="double" width="5" precision="3" utype="Spec:Data.FluxAxis.Value">
<DESCRIPTION> Differential U (variable -comparison) </DESCRIPTION>
</FIELD>
<FIELD ID="col6" ucd="em.opt.B;em.opt.V;arith.diff" name="DBDV" unit="mag"
datatype="double" width="5" precision="3" utype="Spec:Data.FluxAxis.Value">
<DESCRIPTION> Differential (B-V) color (variable -comparison)
</DESCRIPTION>
</FIELD>
<DATA>
<TABLEDATA>
<TR>
<TD>3753.6326</TD>
<TD>0.6114</TD>
<TD>-0.309</TD>
<TD>-0.2212</TD>
<TD>-0.126</TD>
<TD>0.088</TD>
</TR>
<TR>
```

Summary

- We need a time series data model
- The VO community have interesting problems which need that model
- Our starting point can be the spectrum data model
- A (small?) working group would be necessary