# Virtual Observatory

#### Štefan Parimucha





# What is Virtual Observatory?

connection of many different astronomical *datasets* and other resources and *software tools* that should work together and give us opportunity to analyze astronomical data



# Why we need VO?

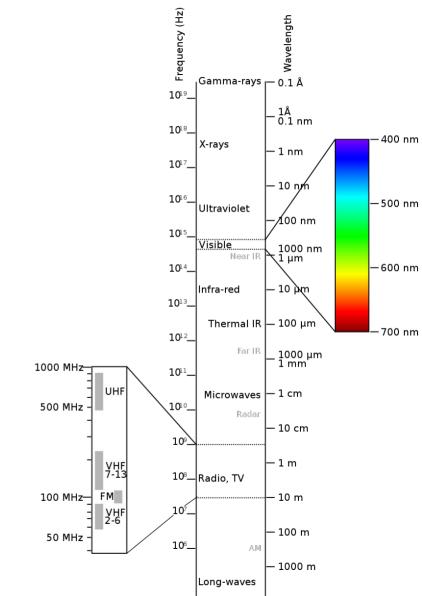
- There is a huge amount of data obtained by different instruments (ground base, space) practically in the whole spectral region
- The most of them are from surveys and big telescopes

Sky Survey Projects	Data Volume		
DPOSS (The Palomar Digital Sky Survey)	3 TB		
2MASS (The Two Micron All-Sky Survey)	10 TB		
GBT (Green Bank Telescope)	20 PB		
GALEX (The Galaxy Evolution Explorer )	30 TB		
SDSS (The Sloan Digital Sky Survey)	40 TB		
SkyMapper Southern Sky Survey	500 TB		
PanSTARRS (The Panoramic Survey Telescope and Rapid Response System)	~ 40 PB expected		
LSST (The Large Synoptic Survey Telescope)	~ 200 PB expected		
SKA (The Square Kilometer Array)	~ 4.6 EB expected		

Zhang, Y and Zhao, Y 2015 Astronomy in the Big Data Era. Data Science Journal, 14: 11, pp. 1–9,

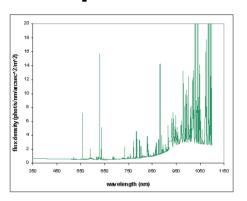
 Data are obtained in almost all passbands, from long radio wavelengts to highenergetic gamma radiation

Moreover we have particle radiation



#### We have different types of data

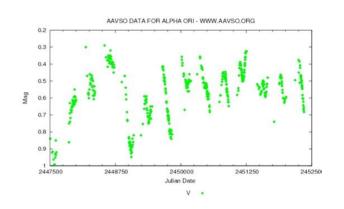
Spectra



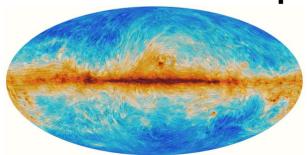
**Images** 



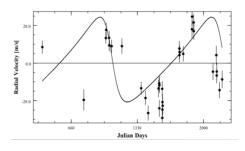
**Light-curves** 



Polarisation maps



#### **Radial velocities**



 We have data in many different catalogs (HIP, GSC, SAO, USNO-B1.0, SDSS, GAIA) – problems with cross-identification

- Data are in different formats
  - most of them are in standard **FITS**, but it is quite flexible standard...
  - csv, txt, xls...
  - multi-dimensional data data cubes

 There are huge amount of objects in the universe: stars, galaxies, exoplanets, nebulae, clusters, quasars, radio sources, ....

 The biggest problem – data from different instruments and telescopes have different quality and formats

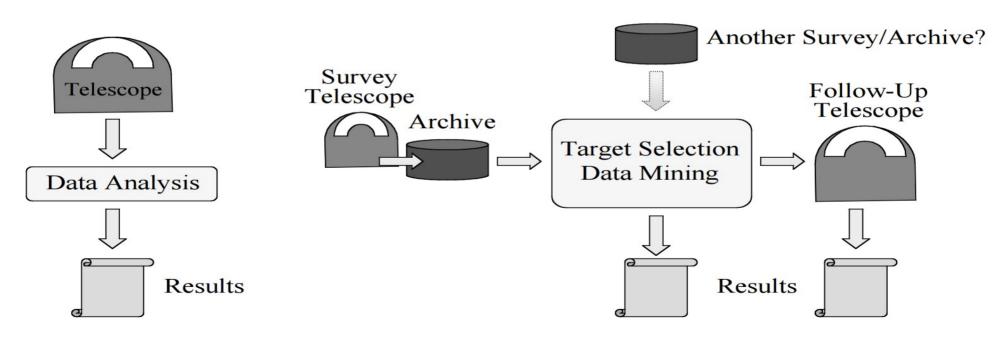
# Why we need VO?

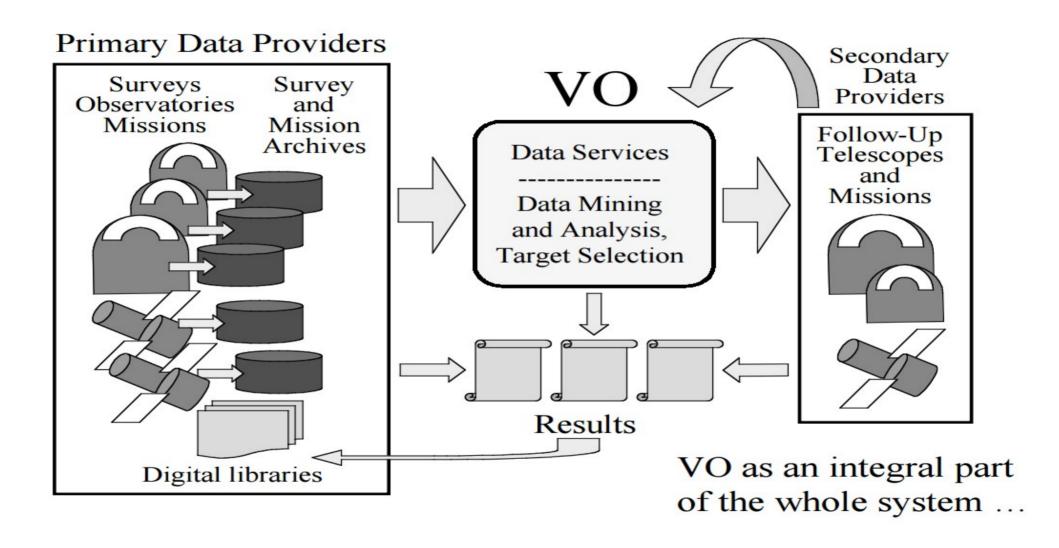
- platform for an analysis and interpretation of multi-source astronomical data in the whole spectral region with different techniques
- Store and preserve data
- Develop software for a data visualization, big data analysis, data-mining, statistics...

# VO change our attitude to data gathering and analysis

#### **TRADITIONAL:**

#### **SURVEY-BASED:**

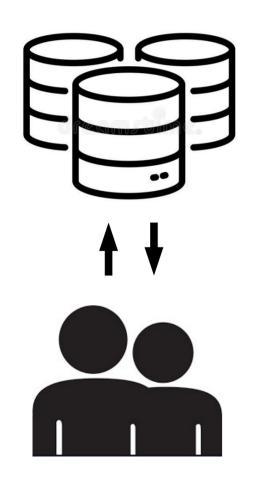




### What we can expect from VO?

- Systematic research of the universe
- Discoveries of rare and/or unknown objects and phenomenons
- Time changes of the objects
- High-precise cosmology, stellar astronomy, Galaxy structure
- Multivariate correlations in data

#### How it works?



Data are stored in an arbitrary format on servers or in data centers at observatories, universities, .... (MySQL, PostgreSQL, Oracle...)

User send request by some software or web

Data from server are sent back to user in standardized format defined by data protocol (xml file)

#### Some software for VO





X-Match

Portal Simbad VizieR Aladin X-Match Other

#### SIMBAD Astronomical Database

Queries
basic search
by identifier
by coordinates
by criteria
reference query
<u>scripts</u>
TAP queries
<u>options</u>
Display all user annotations

Documentation
<u>User's guide</u>
Query by urls
Nomenclature Dictionary
Object types
<u>List of journals</u>
Measurement description
Spectral type coding
User annotations documentation

Information					
Presentation					
Acknowledgment					
Release:					
SIMBAD4 1.225 - Feb-2015					

CKEINH2

#### Content

The SIMBAD astronomical database provides basic data, cross-identifications, bibliography and measurements for astronomical objects outside the solar system.

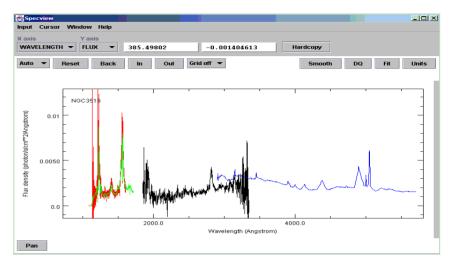
SIMBAD can be queried by object name, coordinates and various criteria. Lists of objects and scripts can be submitted.

Links to some other on-line services are also provided.

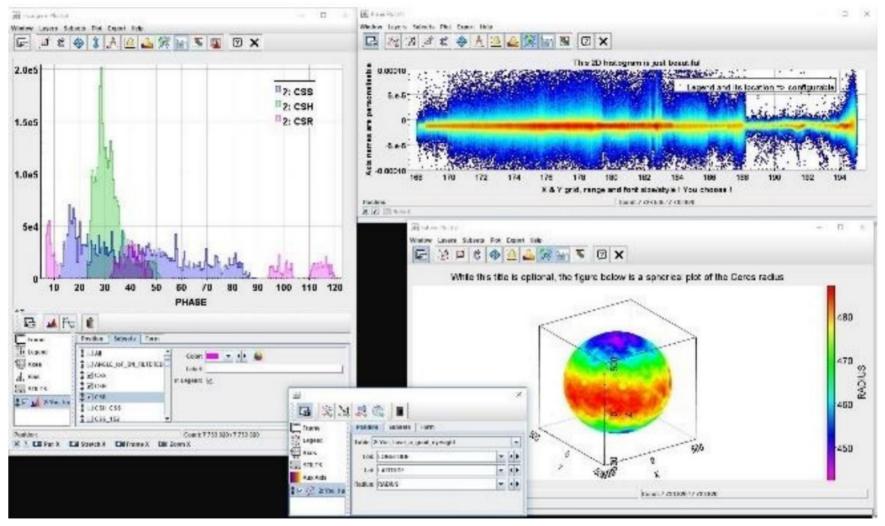
Statistics							
Simbad contains on 2015.03.24							
7,639,318	objects						
21,722,406	identifiers						
301,218	bibliographic references						
11,115,225	citations of objects in papers						

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SplatVO



SpecView



**TopCat** 

#### Some problems

- The most of data in VO are from large telescopes surveys and satellites
- Almost all data are images, spectra and catalog entries (positions, brightness)
- Software for data analysis is either too simple (only display data) or very complicated to use (too many unnecessary functions, user total unfriendly)

• **Small** and **universities** observatories (with telescopes up to 1m) and also many **amateur** astronomers have **unique data**, which cannot be obtained by large telescopes (long time series, rare events observations...)

 Data are not publicly available and there is very high risk of their lost.

- Although there is many surveys focused to time series photometry, mainly due to exoplant search (ASAS, APASS, Catalina, NGTS, SuperWASP, Kepler, TESS,...) there is no VO standard for time series photometry data
- Data from each survey have their own access protocol, problems with object identifications, no standardization

### SKVO SlovaK Virtual Observatory

- Platform for small telescopes (amateur, universities, ...) to contribute to whole astronomical community by VO
- The first goal was to archive and open to world photometric data from our instruments — in slow progress

#### **SKVO**

- Next goals
  - improve transfer protocol (modification of Simple Spectral Access SSA) for photometry
  - improve web of SKVO (skvo.science.upjs.sk)
  - extend for spectroscopy and images

#### **SKVO**

- Next goals
  - open for other institutions and amateurs (after successful testing)
  - develop web-based application for an analysis of photometry
  - try to enforce transfer protocol as a standard in IVOA (together with for other...)

# I WANT YOU



as a volunteer on this project