Publishing Scanned Plates Using DaCHS

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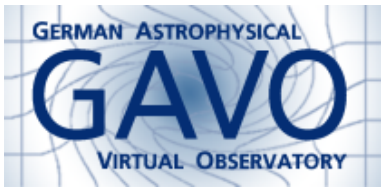
Astroplate 2014, Prague, Vila Lanna

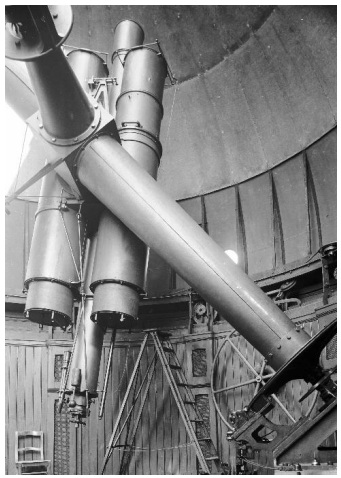


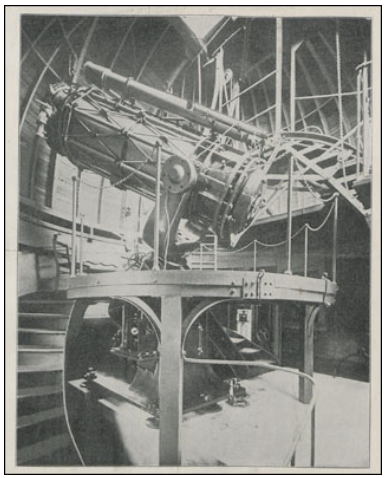
Outline

What Do We Mean by "Preservation of Photographic Plates"?

The Heidelberg Königstuhl Archives (I)

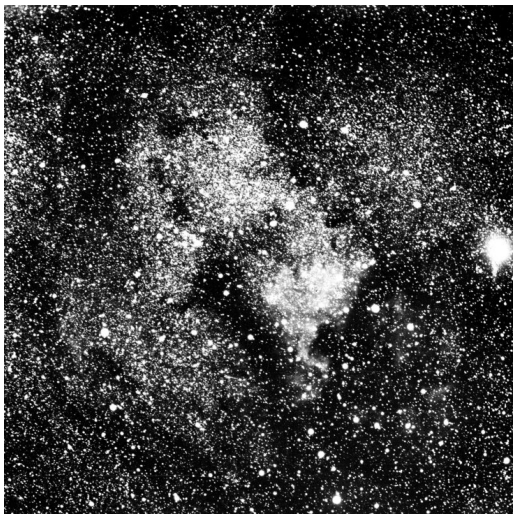
- about 25,000 astronomical photographic plates from various telescopes dating from the late 19th century to our days

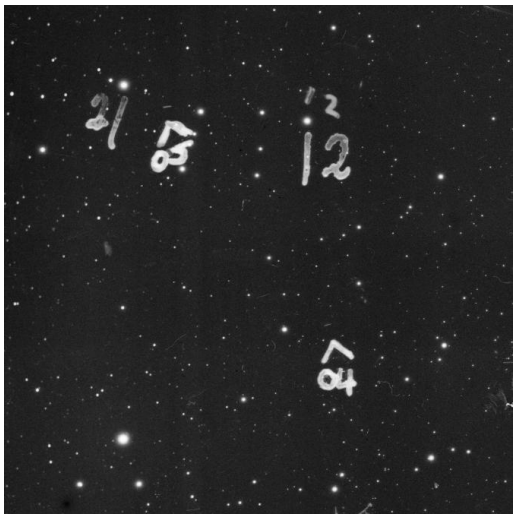





- plates were taken at various instruments
  - Bruce telescope at Königstuhl: $\sim$ 10,000 plates
  - Wolf's double astrograph at Heidelberg-Märzgasse/Königstuhl: $\sim$ 8,000 plates
  - Waltz reflector at Königstuhl: $\sim$ 5,000 photo plates
  - Schmidt telescope at Calar Alto: 400 plates

The Heidelberg Königstuhl Archives (II)





- covering a wide variety of objects of different types
  - nebulae: e.g. NGC 7000 (North America Nebula) taken with Wolf's Double Astrograph in three consecutive nights, September 11-13, 1891
  - minor planets: e.g. the asteroids (325) Heidelberga (label "05") and (175) Andromache (label "04"), January 17, 1909
  - comets: e.g. C/1911 O1 ("Brooks"), September 25, 1911

➥ see poster session for more details on the Königstuhl archives

Preservation of Photo Plates

- preservation of photo plates is a two-step process

Scanning Plates

- ensures the preservation of information despite ongoing oxidative deterioration of the photo emulsions

Publishing Plates

- ensures the persistence of the archives and the standardised access to them

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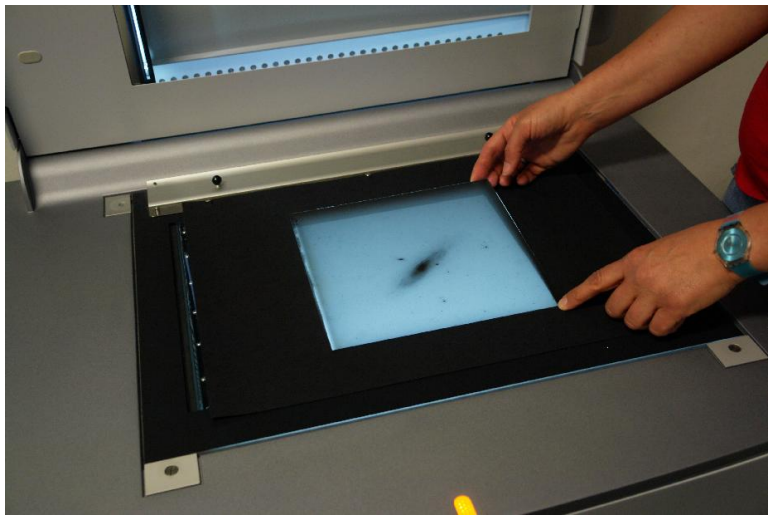
- Heidelberg-Königstuhl scan project (2005-2014):
  - digitization of the Königstuhl archives
  - subsequent storage and publication of the scanned plates by using the infrastructure of the German Astrophysical Virtual Observatory (GAVO)

How Do We Digitise Our Photographic Plates?

Scanning the Plates

- Nexscan F4100 professional scanner of the "Heidelberg Druckmaschinen AG"
  - 315 mm x 457 mm scan area which is masked down to the various plate sizes
  - dynamic range: 16 bit/px
  - 5080 dpi optical resolution
  - chosen resolution for the scans: 2550 dpi (compromise between the requirements needed for a good scan and the amount of data per digitised plate)



Adding Metadata to the Plates

- digitised plates are stored in the commonly used FITS (Flexible Image Transport System) format with minimal headers (basically, NAXISn and BITPIX)
- observation journals are digitised into a plate database providing information about e.g. the observer, the observation time, and the exposure time
- information from the journals together with some plate-specific metadata (e.g. the instrument name or the photo emulsion used) is added to the FITS headers
- program SExtractor writes the objects found on a photo plate in (x, y) to a catalogue
- Astrometry.net tool is used for assigning $(x, y) \rightarrow (\alpha, \delta)$

Which Publication Infrastructure Is Available in the Virtual Observatory?

A Few Words on the Virtual Observatory

The Virtual Observatory (VO) is about...

Archiving Data

storage of all types of astronomical data, e.g.

- catalogues,
- images,
- spectra,
- ...

in data centres which can be accessed from all over the world

Developing Applications

interoperable tools that can be used to

- retrieve data taken by telescopes from all over the world
- analyse, manipulate or visualise astronomical data sets

Defining "Standards"

development of specifications on how

- data should look like ("data models")
- two or more machines should query and exchange data ("protocols")

Standards in the VO (I)

To define standards means to give an answer to questions like...

- In which format should I store my data?
- How should the model that describes my data look like?
- Which metadata should come along with a piece of data?
- Which "language" should be used for communication between two or more machines?

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➥ large variety of data models and protocols defined by the Virtual Observatory community over the years

International
Virtual
Observatory
Alliance

Simple Image Access Specification
Version 1.0

IVOA Recommendation 2009-11-16

Standards in the VO (II)

- "Simple Image Access Protocol" (SIAP):
  - allows for retrieving image data out of a variety of astronomical repositories by using a uniform interface
  - for a query based on a certain sky region the service returns a list of image candidates

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- "ObsCore Data Model"
  - data model used to describe observational data
  - includes data elements like the name of the astronomical object observed, the exposure time, and the URL required to download the data

➥ combining the ObsCore model and TAP: "ObsTAP"

Standards in the VO (III)

- Why publishing your archive according to VO Standards?
  - data can be discovered by in-client standard interfaces (e.g. in TOPCAT)
  - data can be used with standard clients
  - data comes along with standard metadata helping later scientific exploitation

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  - the technical obstacles seem to be larger than the benefits of using VO Standards

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➥ GAVO offers a piece of software that tries to lower that barrier

GAVO's Data Center Helper Suite (DaCHS)

- DaCHS...
  - is a multi-protocol VO server implementing all major VO protocols
  - contains a variety of parsers for input data files, e.g. text files or FITS images
  - contains the Stan templating system of Python's web development framework Nevow allowing for the publication of HTML form-based services and documentation pages

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- central concept of DaCHS' publication infrastructure: the Resource Descriptor (RD):
  - an XML file (typically, there is one RD per data collection)
  - contains all the metadata for a data archive
  - generates the services to be provided for the data

How To Publish Your Plate Archive to the Virtual Observatory?

Steps Towards a VO Publication: DaCHS Installation

- the preferred way to run DaCHS is on Debian or compatible systems on which it can be installed from GAVO's APT repository:
  - add `deb http://vo.ari.uni-heidelberg.de/debian stable main` to the file */etc/apt/sources.list*
  - update the package cache: `sudo apt-get update`
  - install the Debian package: `sudo apt-get install gavodachs-server`

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➥ after doing these steps, DaCHS is on your machine ready for use...

Steps Towards a VO Publication: Writing an RD (I)

- find a detailed description on how to write a Resource Descriptor at `http://docs.g-vo.org/DaCHS/tutorial.pdf`
- start writing your RD by giving the `<resource>` root element of your xml file followed by some metadata:

```
<resource resdir="lswscans" schema="lsw">
    <meta name="creationDate">2007-11-10T12:00:00Z</meta>
    <meta name="description">Scans of plates obtained at Landessternwarte
        Heidelberg-Königstuhl, 1880 through 1999.</meta>
    <meta name="title">HDAP -- Heidelberg Digitized Astronomical
        Plates</meta>
    ...
</resource>
```

Steps Towards a VO Publication: Writing an RD (II)

- define your database table(s):

```
<resource resdir="lswscans" schema="lsw">
    ...
    <table id="plates" onDisk="True" adql="True" mixin="//siap#pgs">
        <column name="exposure" tablehead="Exp. time"
            unit="s" ucd="time.duration;obs.exposure"
            description="Effective exposure time" verbLevel="15"/>
        <column name="object"  type="text"
            tablehead="Targ. Obj." ucd="meta.id"
            description="Special object on plate" verbLevel="15"/>
        ...
    </table>
</resource>
```

  - `<column>` elements set the fields of the database table
  - `<mixin>` means: run internal code to endow the table with everything needed for a specific service (here: SIAP)

Steps Towards a VO Publication: Writing an RD (III)

- write your data ingestion component:

```
<resource resdir="lswscans" schema="lsw">
    ...
    <data id="import" updating="True">
        <sources recurse="True">
            <pattern>data/part1/*.fits</pattern>
            <pattern>data/part2/*.fits</pattern>
        </sources>
        <fitsProdGrammar qnd="True" id="impGrammar">
            ...
        </fitsProdGrammar>
        <make table="plates" rowmaker="make_plates"/>
    </data>
</resource>
```

  - the input data sets are declared within the `<sources>` elements
  - grammar chosen here returns FITS headers as dictionaries, i.e. a sequence of string-to-string mappings
  - `<rowmaker>` elements turn these mappings into proper database rows

Steps Towards a VO Publication: Writing an RD (IV)

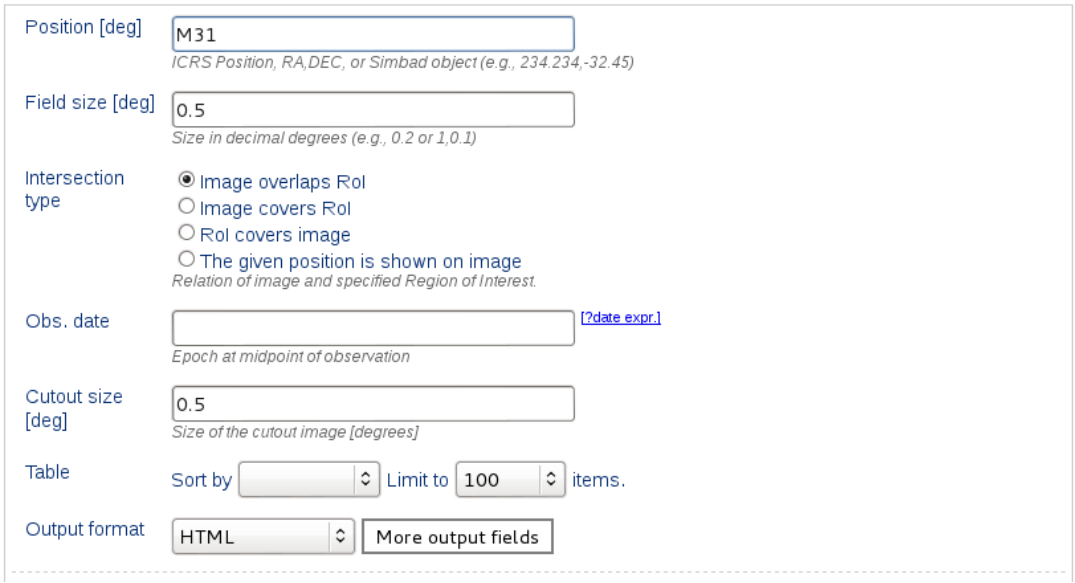
- define the service(s) exposing the data:

```
<resource resdir="lswscans" schema="lsw">
    ...
    <service id="siap" core="qhsiap" allowed="siap.xml">
        <publish render="siap.xml" sets="ivo_managed"/>
        <publish render="form" sets="ivo_managed" service="q"/>
        <meta name="shortName">hdap_siap</meta>
        ...
   </service>
</resource>
```

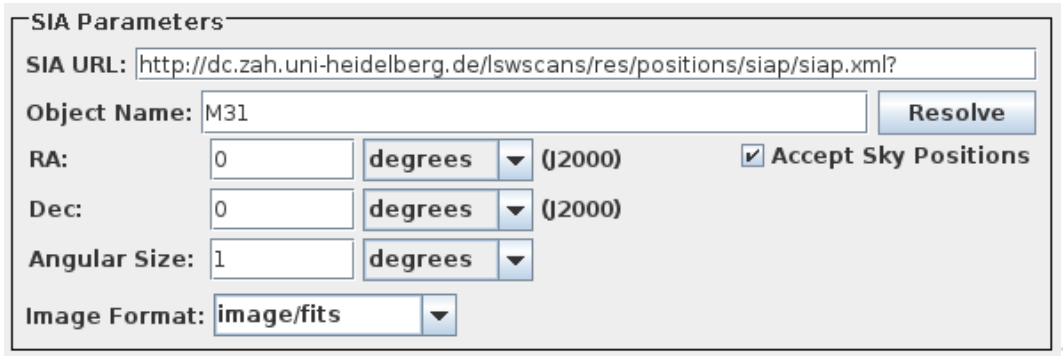
  - a service is a combination of a core and one or more renderers
  - a core is the element which performs the actual computations for the service
  - renderers set the interface(s), here a web form ("form") and an SIAP interface ("siap.xml")

And there It Is...

- `http://dc.zah.uni-heidelberg.de/lswscans/res/positions/q/form`



- TOPCAT's built-in SIAP client



Summary

- preservation of astronomical photographic plates is (at least) a two-step process comprising the digitisation and the publication of the data
- the software package DaCHS is in operation in various data centres all over the world
- due to its powerful publication infrastructure supporting to Virtual Observatory standards, DaCHS provides a reasonably smooth path for publishing scanned photo plates
- technical support for your data publication is available from the GAVO Heidelberg team at gavo@ari.uni-heidelberg.de

References

- The GAVO Data Center, http://dc.zah.uni-heidelberg.de/.
- Tody, D.; Plante, R. (2009), Simple Image Access Specification, IVOA Standards, http://www.ivoa.net/documents/SIA/20091116/.
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- Full plate access to Heidelberg Digitized Astronomical Plates, http://dc.zah.uni-heidelberg.de/lswscans/res/positions/fullplates/form.