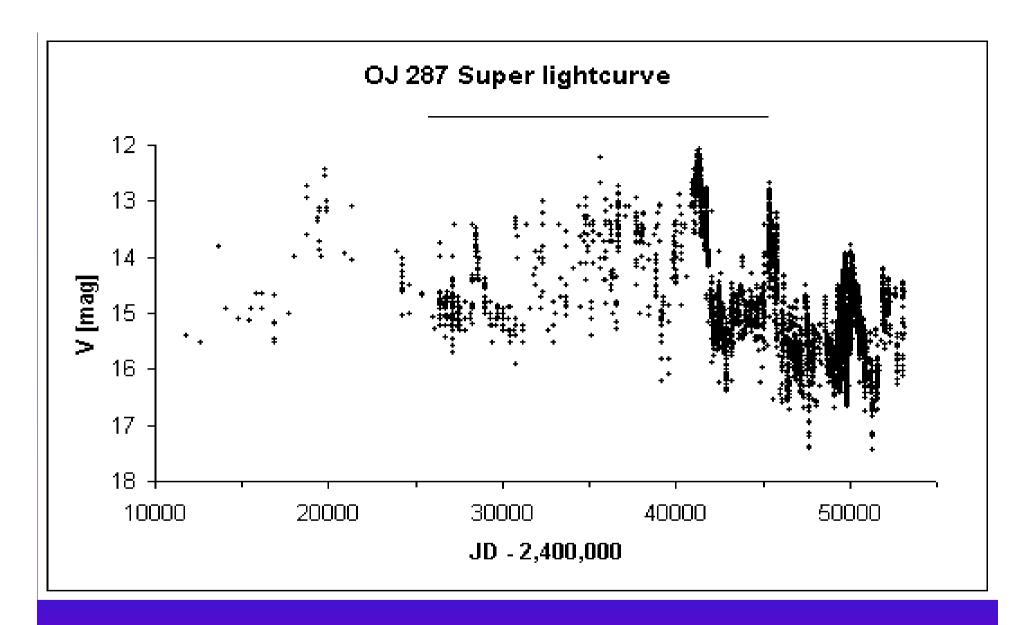
Astronomical Plate Archives: Past, Present, Future

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OJ287 - long term light curve (> 100 years), the only well studied case. Example of importance of long-term studies in aastrophysics. Possible only with photographic, data archives.

The Plate Archives

- The recording medium in astronomy (and not only astronomy) for recording images was photographic emulsion until about 1980, i.e. for about 100 years
- Hence all scientific Institutes involved in the past in imaging are expected to have archives of recorded images (as photographic negatives)

Photographic Negative Archives

- Astronomical
- Non-astronomical
- Other sciences
- National Archives
- Musea
- Others

- Glass negatives
- Plastic negatives / planfilms
- Rolfilms

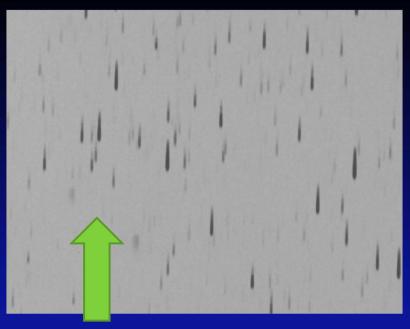
Archival sky patrol plates

- There are more than 7 millions astronomical archival plates and negatives in the world, lim mag up to 23, > 5 x 5 deg in most cases
- Suitable for dense long-term photometry (up to 100 years, up to 2000 points, up to 23 mag)
- Suitable to detect rare events years od CONTINUOUS monitoring easily possible
- However, the access to the data is still difficult, but:
- Recently, efforts to digitize the plates
- Use of scanners, powerful computers and innovative software allows the effective data evaluation for the first time
- 1 plate ~ 3 x 10⁴ stars, 3 x 10⁶ plates10¹¹ stars recorded ... 10¹¹ photometric points

Astronomical Negatives

- Direct images
- Low DispersionSpectra
- Multiple images
- Spectra

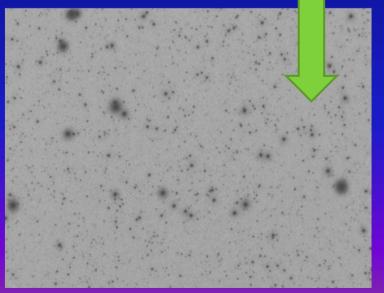
- Stars / Night Sky Images
- Meteor trailed images
- Planets
- Sun
- Moon
- Other targets



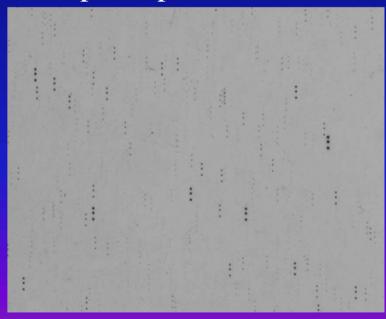
Various types of astronomical plates (digitised)

- •wide-field $>> 1 \times 1 \deg$
- •narrow field $< 1 \times 1 \deg$

Spectral image Direct Image



Multiple exposure



Personal visits to astronomical plate archives

- I have personally visited and evaluated the plates in more than 50 plate archives
- In numerous cases sad experience
- In few cases forbidden entry, then mostly plates badly damaged
- In most cases plates stored not in proper conditions
- Many hidden plate collections found
- Mostly scientific valuable databases
- In numerous cases no contact person, no funding, no equipment

List/Catalogue of astronomical plate archives

- Complete list does not exist
- Many are included in WFPDB (Tsvetkov et al.)
- But this is not complete
- America archives list by Wayne et al., but, again, not complete
- Examples: numerous unknown archives found by us even at those Institutions where the management was not aware that they have plate archive
- Total numbers difficult to estimate, as at many archives they do not know how many plates they have

The largest plate/negative archives (some unknown before)

- HCO USA 500 000 plates
- Carnegie Pasadena USA 500 000 plates
- Sonneberg 280 000 plates
- OHP France 250 000 plates
- Charlottesville VA USA 165 000 plates
- Swathmore Observatory PA USA 100 000 plates
- PARI USA 220 000 plates/negatives
- RGO UK 150 000 plates/negatives

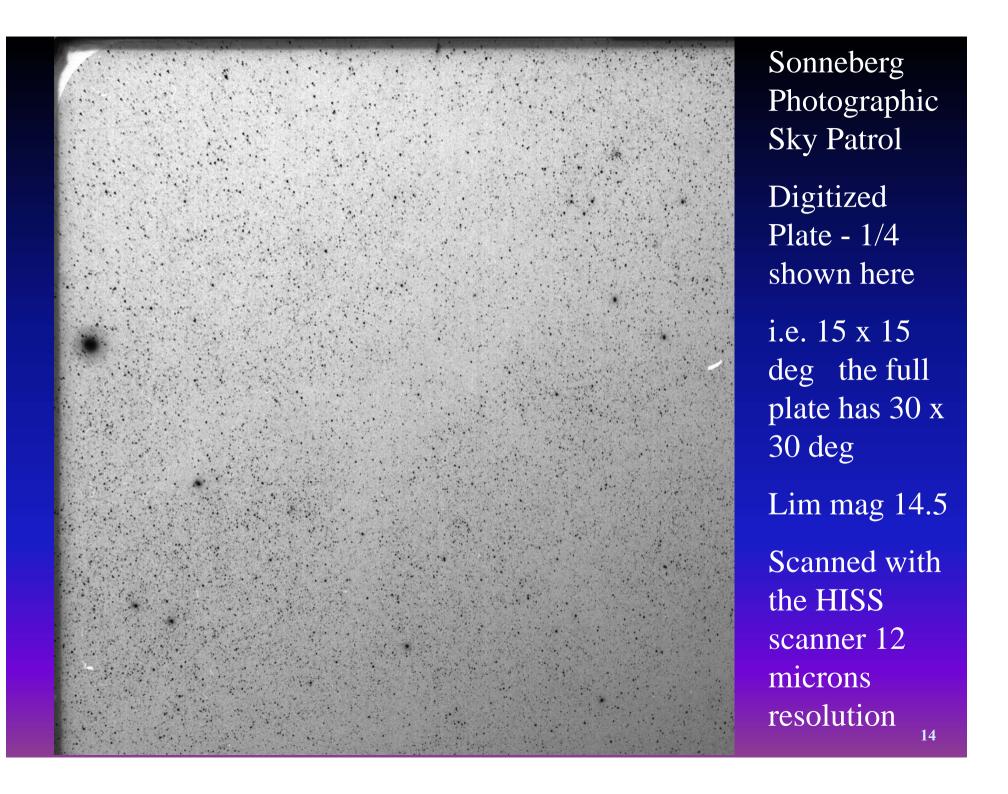
The astronomical plates taken by largest telescopes

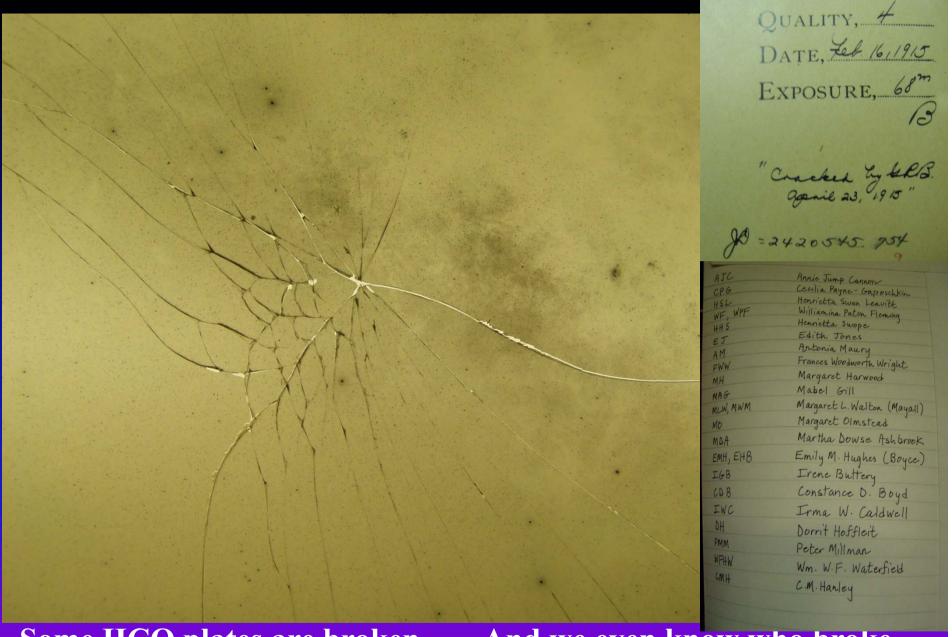
- CFHT Hawaii USA, 3.6 m aperture
- UKSTU Siding Springs Australia
- Australia 4.0 m aperture

The astronomical negative collections with finest time resolution

- Baker-Nunn Camera networks archives, USA,
- Time resolution few seconds, FOV 5 x 30 degrees, lim mag 14-16

The plates and films



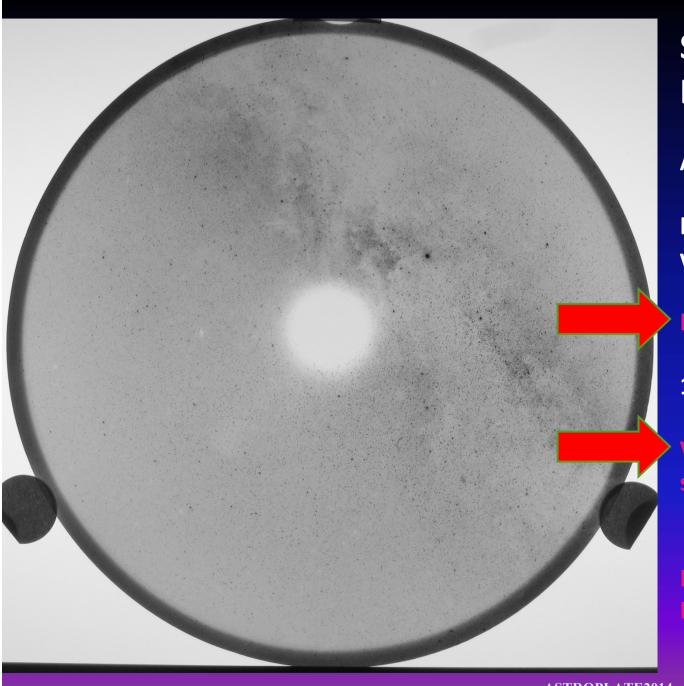


Some HCO plates are broken And we even know who broke them almost 100 years ago

15



... and some were carefully examined dozens of years ago.....



Super-Schmidt Baker Camera

About 100 000 films

Limiting magnitude 15, very sharp images

FOV 55 degrees

1950-1960

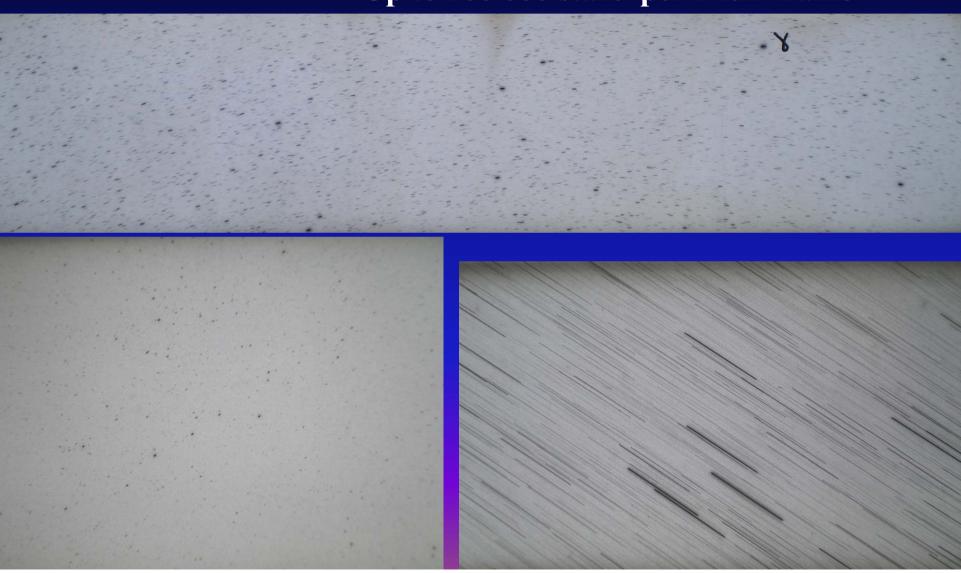
Very dense (20 minutes) sampling

Now deposited at PARI,



Data suitable for wide-field studies, OT searches, fast variablity

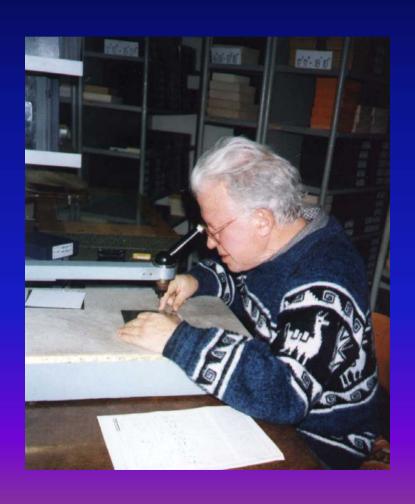
Up to 100 000 stars per 1 full frame



Extracting the information recorded in the plates:

- •dedicated high quality plate scanners D very expensive
- •commercially available flatbed scanners D moderately expensive
- •other instruments (photometers etc.)
- •by human eye
- •by a CCD camera D inexpensive

History: evaluation of archival plates by eye estimation



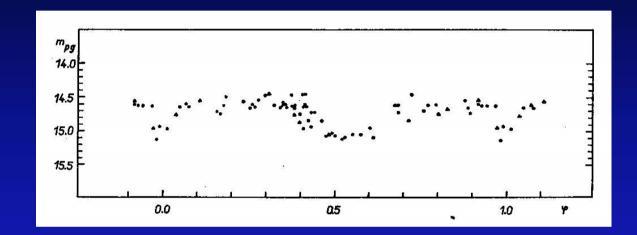
Eye estimation can however still yields valuable results:

Experienced person can provide measurements with precision analogous to plate photometers and CCD scanning

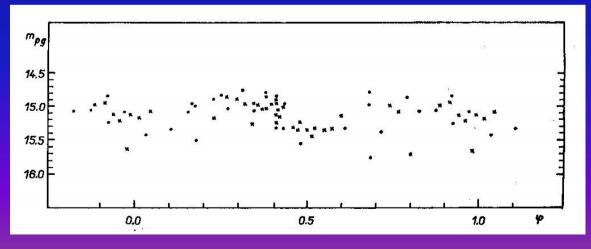
The method is quick and suitable for evaluation of on many plates where digitization is less effective

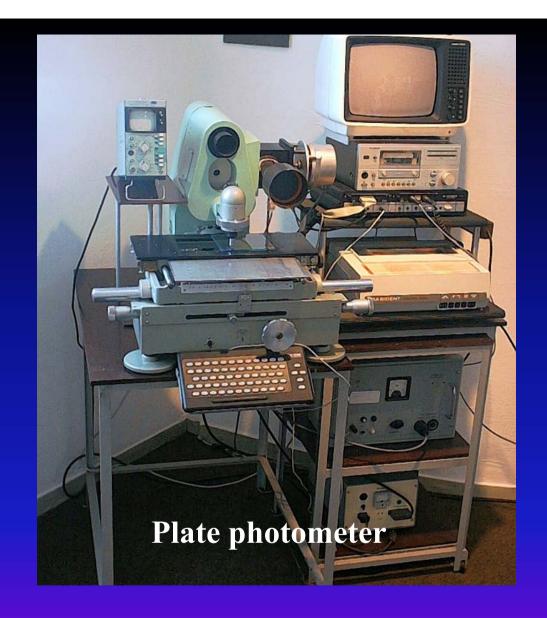
Comparison of eye estimation by experienced person with plate photometer - HZ Her inactive state, Sonneberg Observatory astrograph plates

eye



photometer





Old instrumentation for plate analyses, Sonneberg



Blinkmicroscopes



Plate informations

- Observing logs
- In hand written form
- Some fraction transferred to files: absolutely necessary step
- Plate searches by computers
- Searchable www forms
- Goal is to find plates which include the object of interest (or given sky position)

Are glass plates and/or films reliable medium for data storage?

Yes and No





Yes - if carefully stored, the plates will hardly degradate over next 100 years or even more. But for astronomical plates, this is mostly not the case

But - there is a danger that the plates can be almost completely destroyed e.g. by water, as shown by floods in Prague in summer 2002 (200 000 centrally stored archeological photographic plates very seriously affected and badly damaged) TE2014

Damages to plates: need to

digitize fast









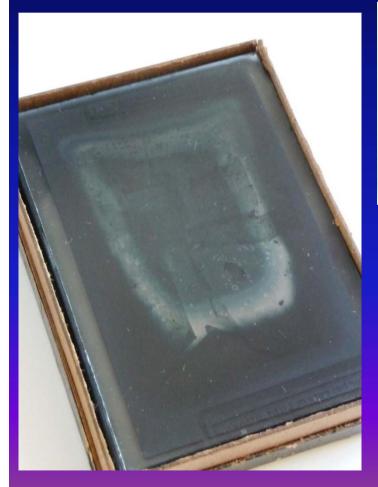
Gold disease and damage by humidity Collaboration with IChT Prague in recovery damaged plates 25 Influence of glue and proper plate storage used around 1925 avoiding glue (Bamberg)





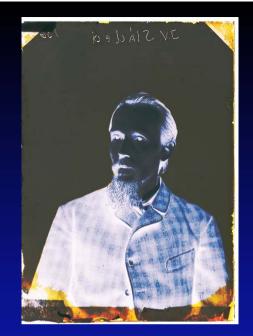


Damages found in nonastronomical negatives











ASTROPLATE2014

New:

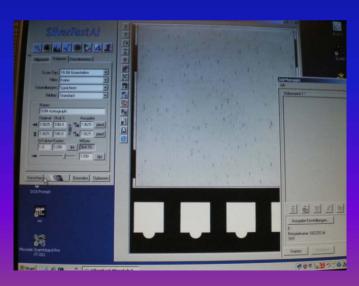
The digitisation of the astronomical plates, the novel software and the use of powerful (1 plate can represent up to 1 GB) computers allow the automated data mining and scientific evaluation of the plates for the first time

Interface between astronomy and informatics (excellent task for informatics students!)



Norbert
Polko:
250 000
plates
scanned:
worlds
record

Scanning Efforts at Sonneberg Observatory more than 250 000 plates already scanned











Past
Glass Plates

Recent DVDs **Future**

Creating Astronomical Plate Centres

- Storing plates which would be otherwise destroyed
- Creating centres with large number of plates and excellent equipment
- Europe: UDAPAC, no success
- USA: PARI, success
- Others? China?

PARI – US Initiative for North American Plates PARI Institute, NC





Recently
about 120
000 plates
there, plans
for more







Conclusions

- Astronomical Plate Archives represent valuable extended (> 7 milion) data source
- Most important: long time evolution, dense sampling, rare flares, spectral changes
- Recent wide digitization and evolution of dedicated software enables evaluation by computers, for the first time
- Storage of negatives in numerous cases is not optimal
- Need for collaboration with archivists and chemists

The End