

# Photographic and Digital Surveys at Sonneberg Observatory

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Large Surveys with small telescopes (ASTROPLATE III)  
Bamberg 2019

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# Sonneberg



# Sonneberg Observatory



# Brief history

- 1925: founded by Cuno Hoffmeister as municipal observatory
- 1931: Branch station of Berlin-Babelsberg Observatory
- 1946: Institute of German Academy of Science
- 1992-1994: Branch station of Tautenburg Observatory
- 1995-2003: Municipal observatory
- since 2004: Operated by private company (Ltd.)  
4 $\pi$  Systeme - Gesellschaft für Astronomie und  
Informationstechnologie mbH
- near future?: associated institute of Coburg University of  
Applied Sciences and Arts?

# Plate collection

- Total: approx. 275,000 plates
- Epochs: 1923 – 2010
- Exposure times: 15' ... 4<sup>h</sup>
- Taken with:
  - Schmidt 500/700/1720 (8,500)
  - Astrographs 400/1950, 400/1600, ... (25,000)
  - Tessars 55/250 (150,000)
  - others
- Plates sizes:  
6 × 6 cm<sup>2</sup>, ..., 13 × 13 cm<sup>2</sup>, ..., 30 × 30 cm<sup>2</sup>
- FoV: 3° ... 30°
- Sky coverage:  $\delta > -30^\circ$ ; + some southern fields
- 99% direct images, 1% spectral plates

# Schmidt telescope: 500/700/1720



Sky Patrol:  $(8 \text{ pg} + 6 \text{ pv}) \times 55/250$ 

# Plate archive: Astrograph plates





# Plate archive: Astrograph plates



# Plate archive: Sky patrol plates



# Digitization

- 1980ies: key punching log books (dBase),  $\approx 90\%$
- 1991: Simple line scanner with projection objective (3 years / 5000 plates)
- 2004: Bulk scanning started
- Today:
  - Small plates (sky patrol): 211,751 scans
  - Big plates (astrograph): 25,679 scans
  - Total: **237,430**  $\approx 85\%$
- Resolution: 20  $\mu\text{m}$  (1200 dpi), 16 bit
- File format: TIFF + gzip compression (to 80% ...90%)  
→ <SCANID>.tif.gz
- Sizes: 72 ... 450 MB (raw data)

# Digitization hardware

HP Scanjet 7400C with illumination unit + VueScan 6.2



# Digitization hardware

Microtek ScanMaker 9800 XL + VueScan 6.2



# Sonneberg Observatory PHotographic Image Archive (SOPHIA)

- Today: total of approx. 25 TB (uncompressed)
- initially 2700 DVDs (double storage!)
- plus 4 HDs (2 TB)
- NEW (since 2019): NAS with 30 TB

# Current and future activities

- Continuing key-punching log books and scan meta data
- Database conversion
- Historic long-time light-curves of prominent objects (e.g. Boyajian's star)
- Search for (rare) outbursts of WZ-Sge-stars
- WCS solution for Sky Patrol plates (see poster SOPHIA)
- New scanner to be procured
- Scanning of remaining plates ( $\approx 40,000$ )
- Scanning of "foreign" plates ( $\approx 5,000$ )
- Integration in APPLAUSE ?

# Digital Surveys: ASPA (not realised)

- Goal: Continuation of sky monitoring by direct digital imaging
- mid 1990ies: initiated by Nikolaus Vogt et al.
- Digital Sky Patrol planned at 6 astro-sites world-wide
- **ASPA** – All-Sky Patrol Astrophysics
- All proposals rejected ...
  
- How to continue? → Set up a (low budget) sky monitoring!
- See also our poster about Sonneberg Observatory Digital All-Sky Survey (SODASS)

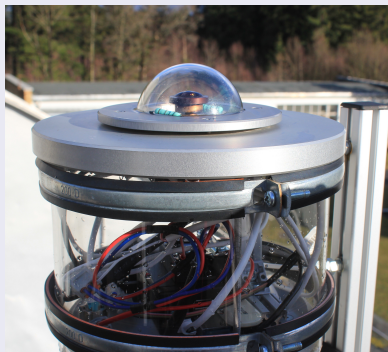


# Fish-eye cameras

Starlight XPress Oculus



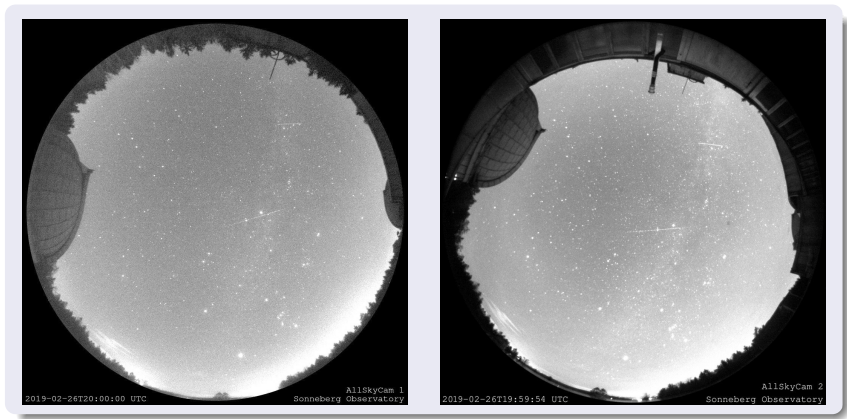
In-house dev. ( $f=1.37$  mm / 2.5)



# Fish-eye cameras

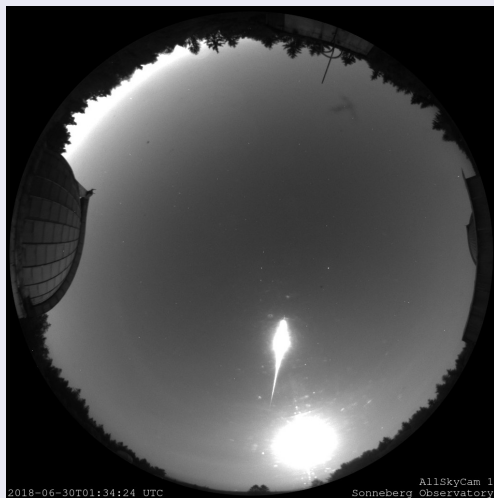
- Operated since 2015 / 2017 (parallel)
- Image size  $1\text{k} \times 1\text{k}$  /  $1.5\text{k} \times 1.5\text{k}$  pixels
- Exposure time: 20 sec, readout: 2.5 sec
- Limiting magnitude (integral):  $6^m$  /  $7^m$  (zenith)
- Continuous monitoring from dawn to dawn (600 ... 2500 images/night)
- Every day: morning video  $\rightarrow$  What happened last night?
- Monitoring of stars: 25,000 ... 100,000 data points/year

# Comparison of the two cameras



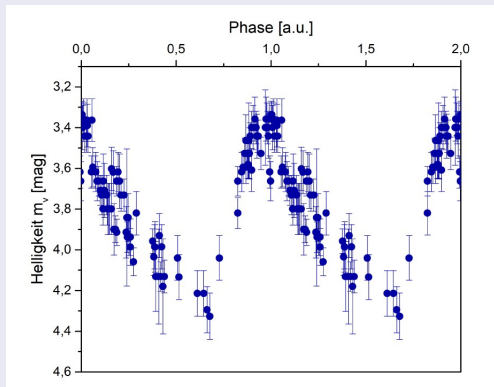
# Bright meteors and fireballs

Fireball of 2018-06-30 → meteorite fall predicted near Bamberg!



# Variable stars

## Test case $\delta$ Cephei



(Classical estimation with Argelander method in other context.  
Automatic photometric reduction still to be made!)

# Field monitoring

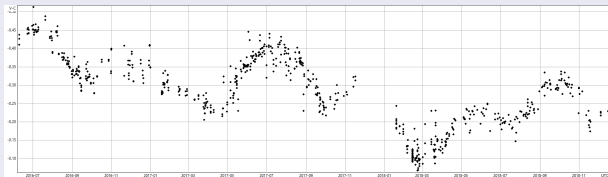
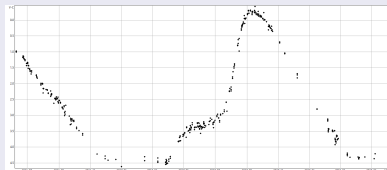
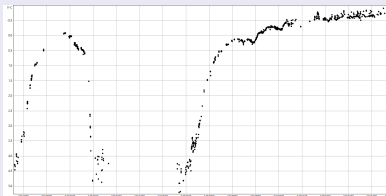
- Goal: going deeper!
- Approach: make use of existing optics with consumer cameras
- Tessar 80/360 mm + Canon EOS 5D Mark 1
- Limiting magnitude (V):  $\approx 12^m$  (3 min)
- Field of view:  $3.8^\circ \times 5.7^\circ$
- Fields selected to observe prominent or important objects
- Running since 2014
- All clear nights used, even gaps of one hour (Walter Fürtig)

# Field monitoring



# Field monitoring

Examples (2014 – present, G channel): R CrB, SX Her, VV Cep





# Next step: Many automatic telescopes

- Goal: Cover all sky at high cadence down to  $12^m$  or deeper
- Approach: Several small telescope (low-cost mount) placed on a parallactic platform (daily motion)
- Study by Simon Gast (2017):

