Sky Brightness Measurements with a Digital Camera: The Effect of a Small Nearby Village (Großmugl) on Night Sky Brightness

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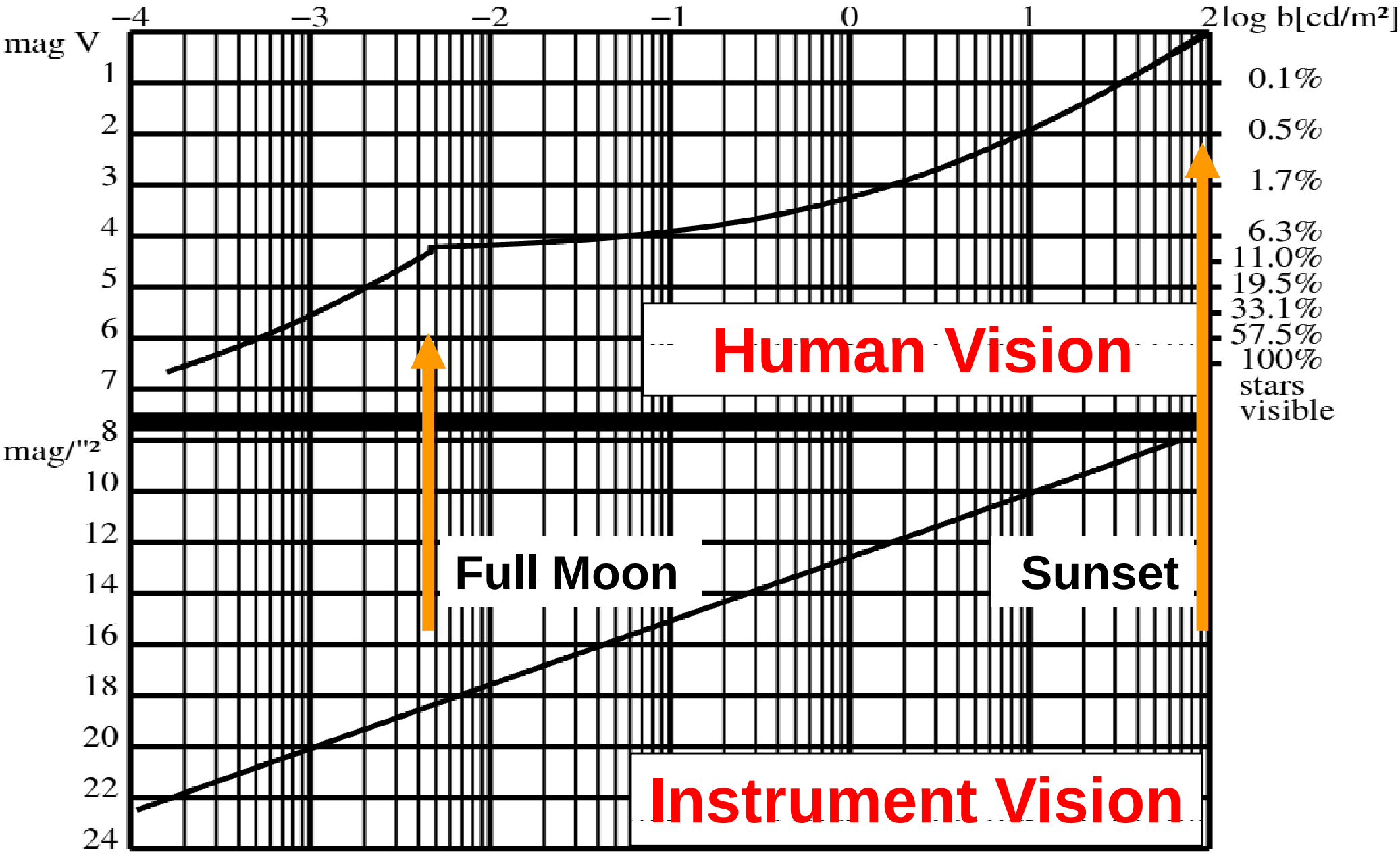
Outline

- Sky Luminance and Stellar Visibility
- High Dynamic Range Photography
- Evaluation of HDR images
- Urban vs. Rural Night Sky
- Großmugl Experiment, Astronomy Day 2008

Sky Luminance and Stellar Visibility



[after Weaver 1947, Garstang 1986, Cinzano 1997]

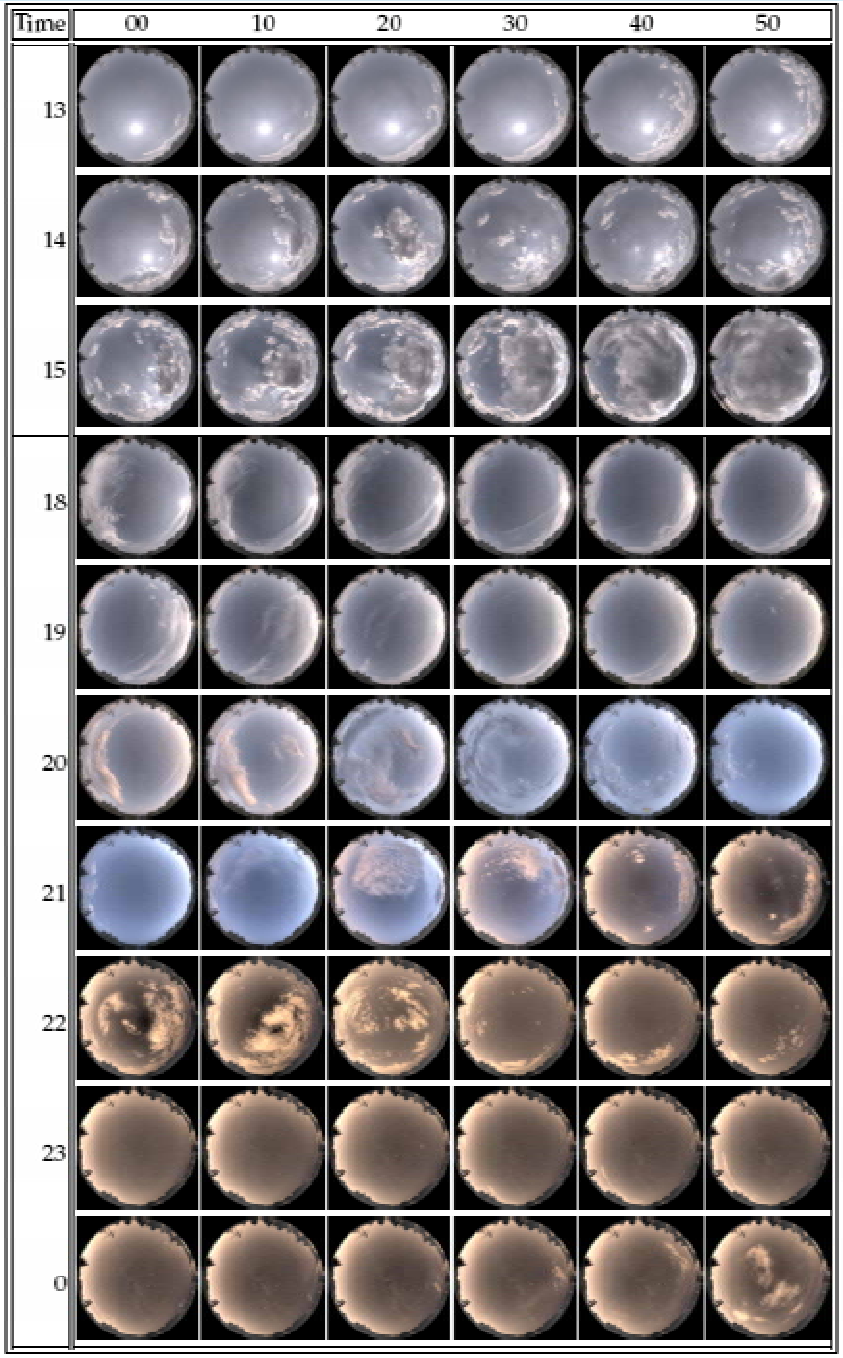
High Dynamic Range Photography

- Combination of several exposures
- Calibration with Luminance Meter
  → *Luminance Map*
  → Photographic Measurement System

Our System

- Camera: Digital SLR
  - All-Sky Fisheye only with *Full-Size Chip* DSLRs
  - RAW image format!
- Free Software:
  - **Dcraw** for RAW image processing
    http://cybercom.net/~dcoffin/dcraw/
  - **PFS Tools** for HDR processing
    http://www.mpi-inf.mpg.de/resources/pfstools/
    - Extensible via GNU Octave
- Calibration:
  - PFS Tools, from EXIF data (approximative)
  - Minolta LS-110 for daylight range
  - Sky Quality Meter for night sky measurements

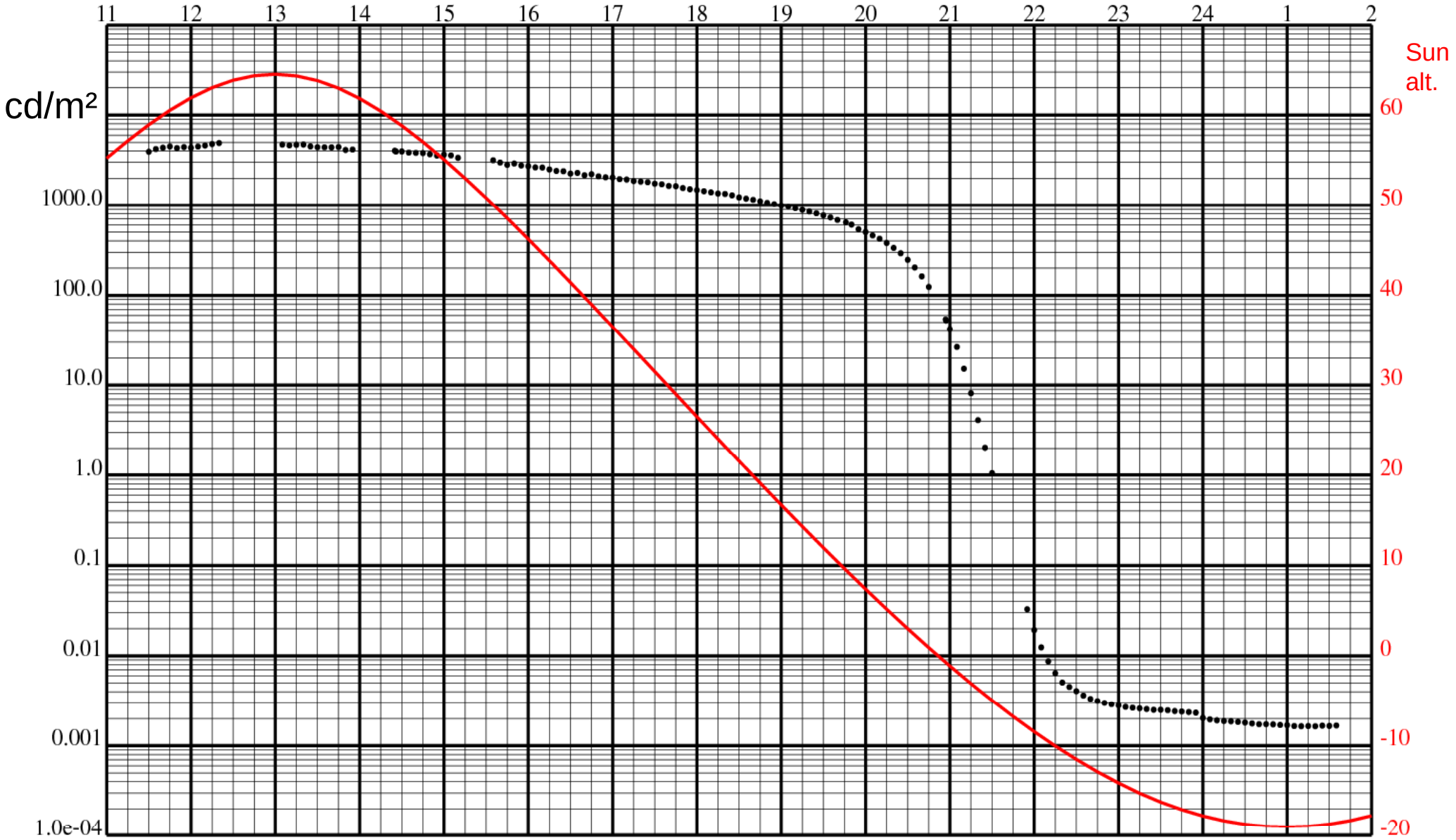
Evaluation of Zenith Luminance



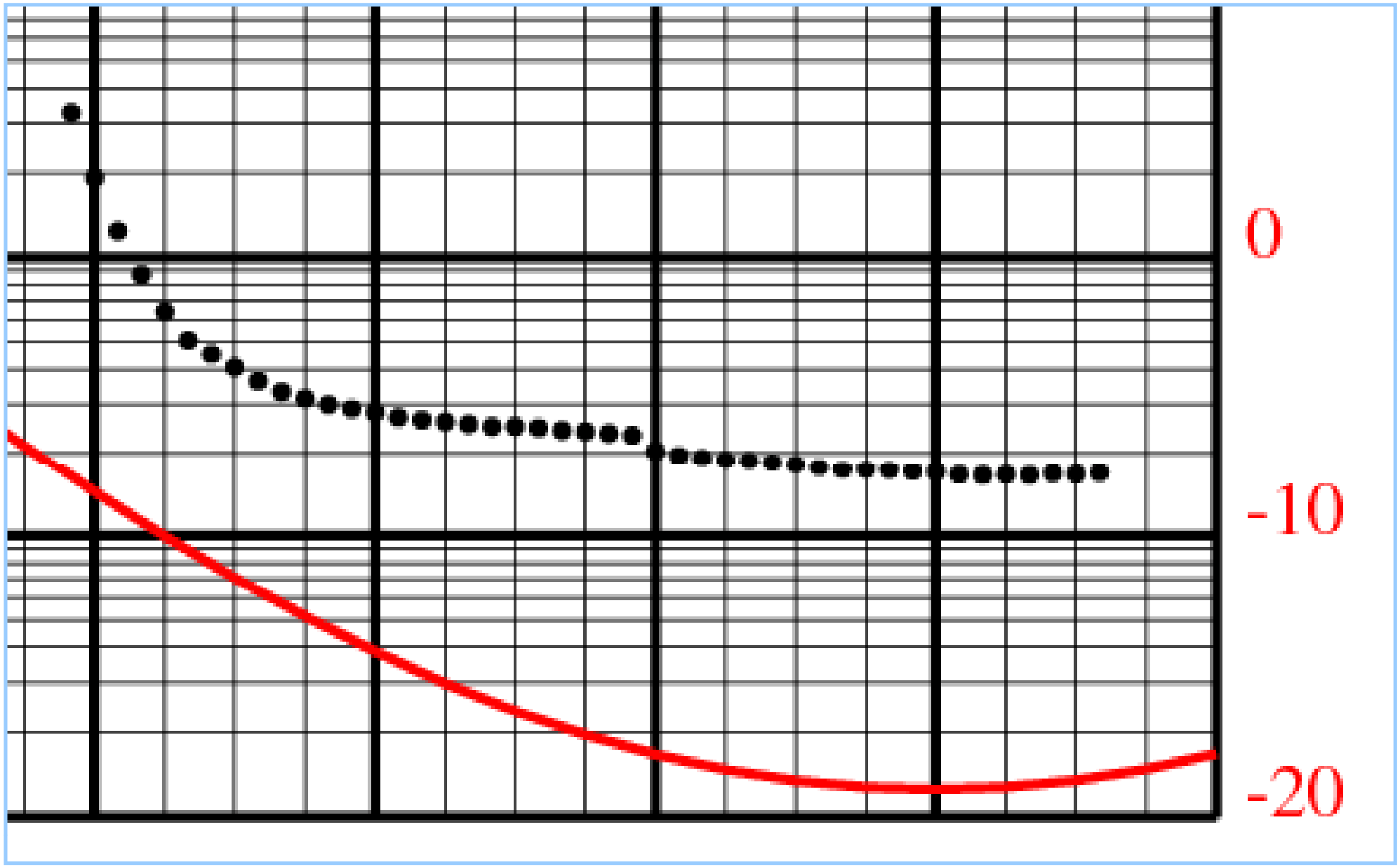
- Series of HDR photos
- Averaged zenith area

← Tonemapped HDR images

Evaluation of Zenith Luminance



Evaluation of Zenith Luminance



Results: Surburb Sky

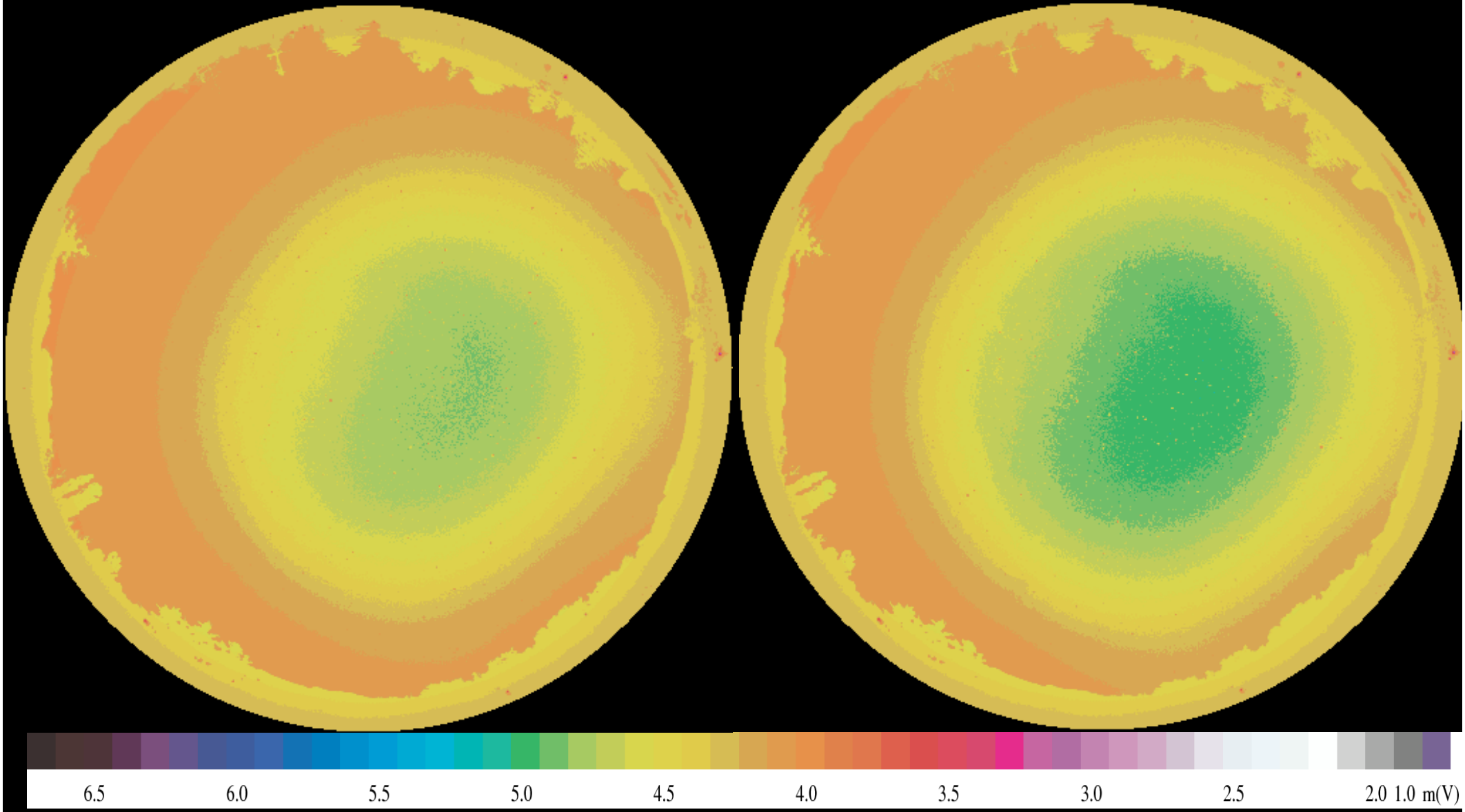
Full illumination

Reduced illumination

Results: Surburb Sky

Full illumination

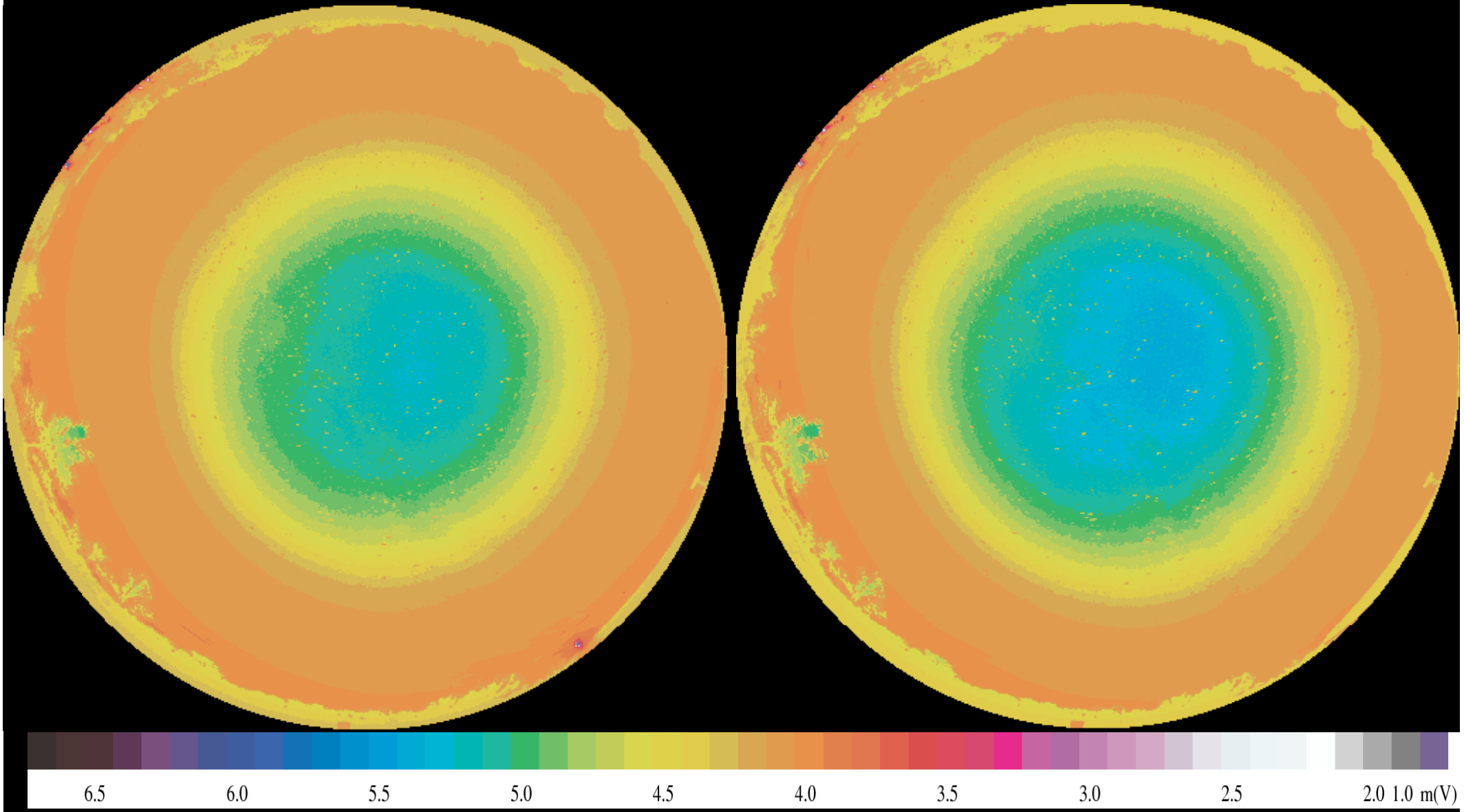
Reduced illumination



Results: City Border (average)

Full illumination

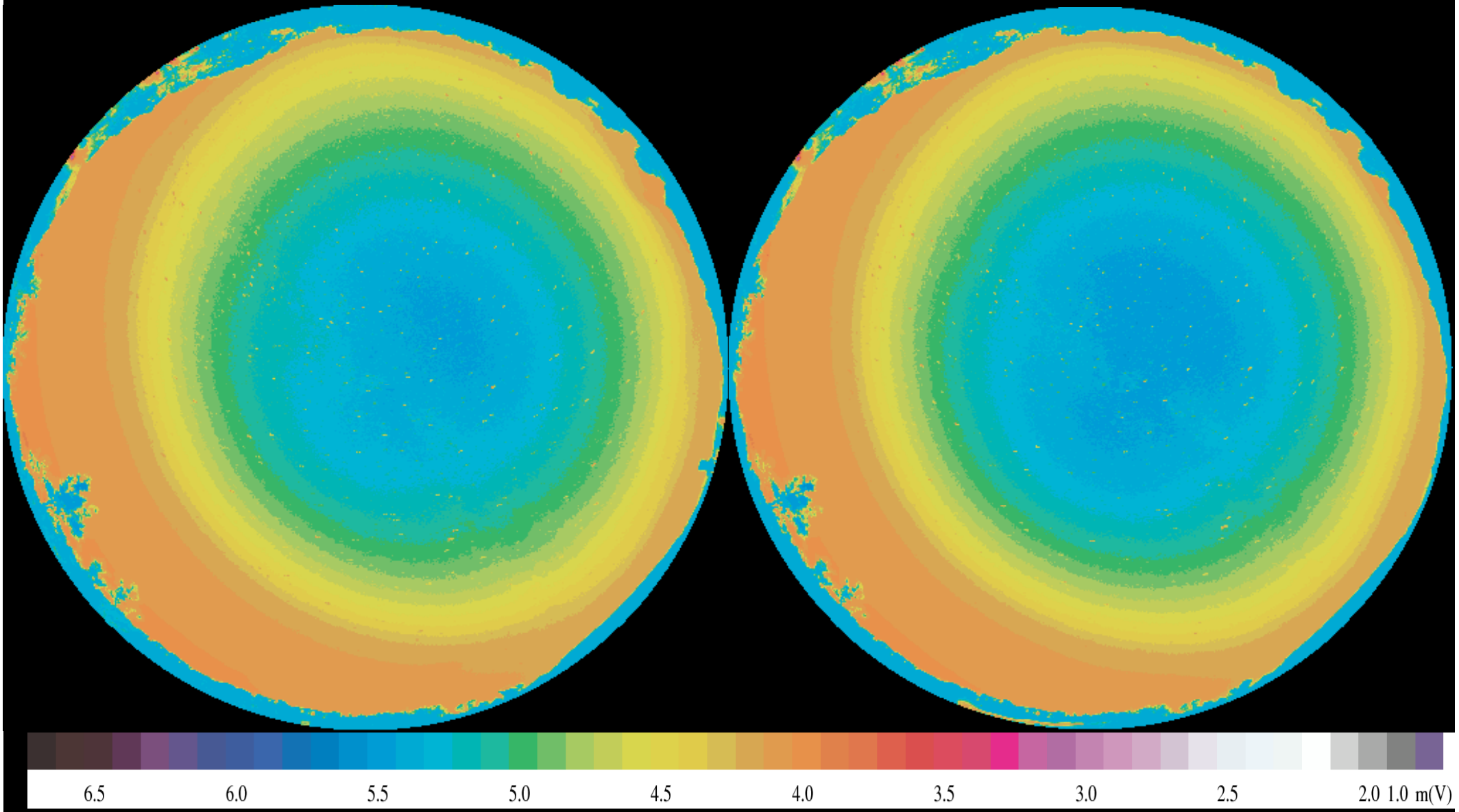
Reduced illumination



Results: City Border (good night)

Full illumination

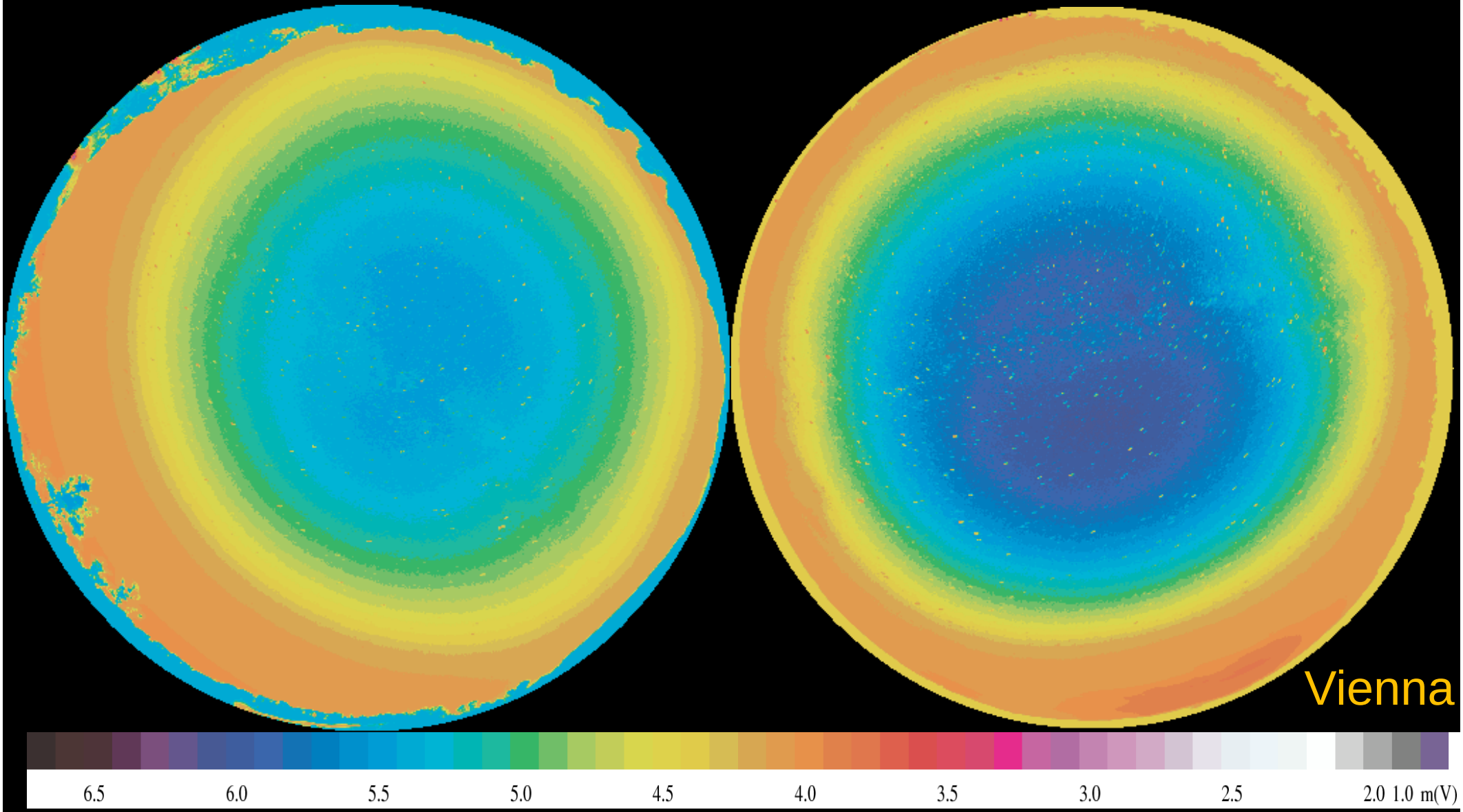
Reduced illumination



Results: City Border / 20km from Vienna

mag5.5

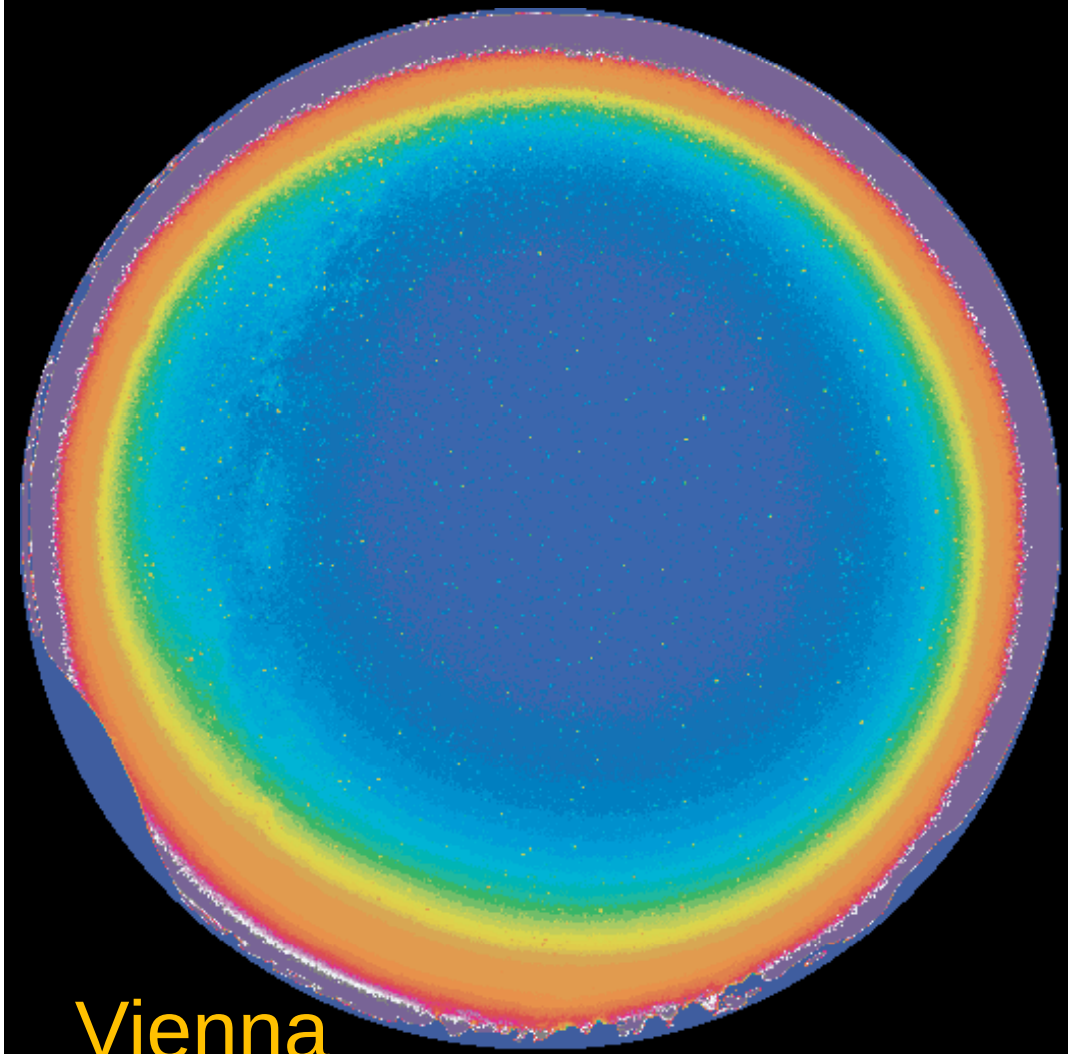
Großmugl near Vienna, *mag6*

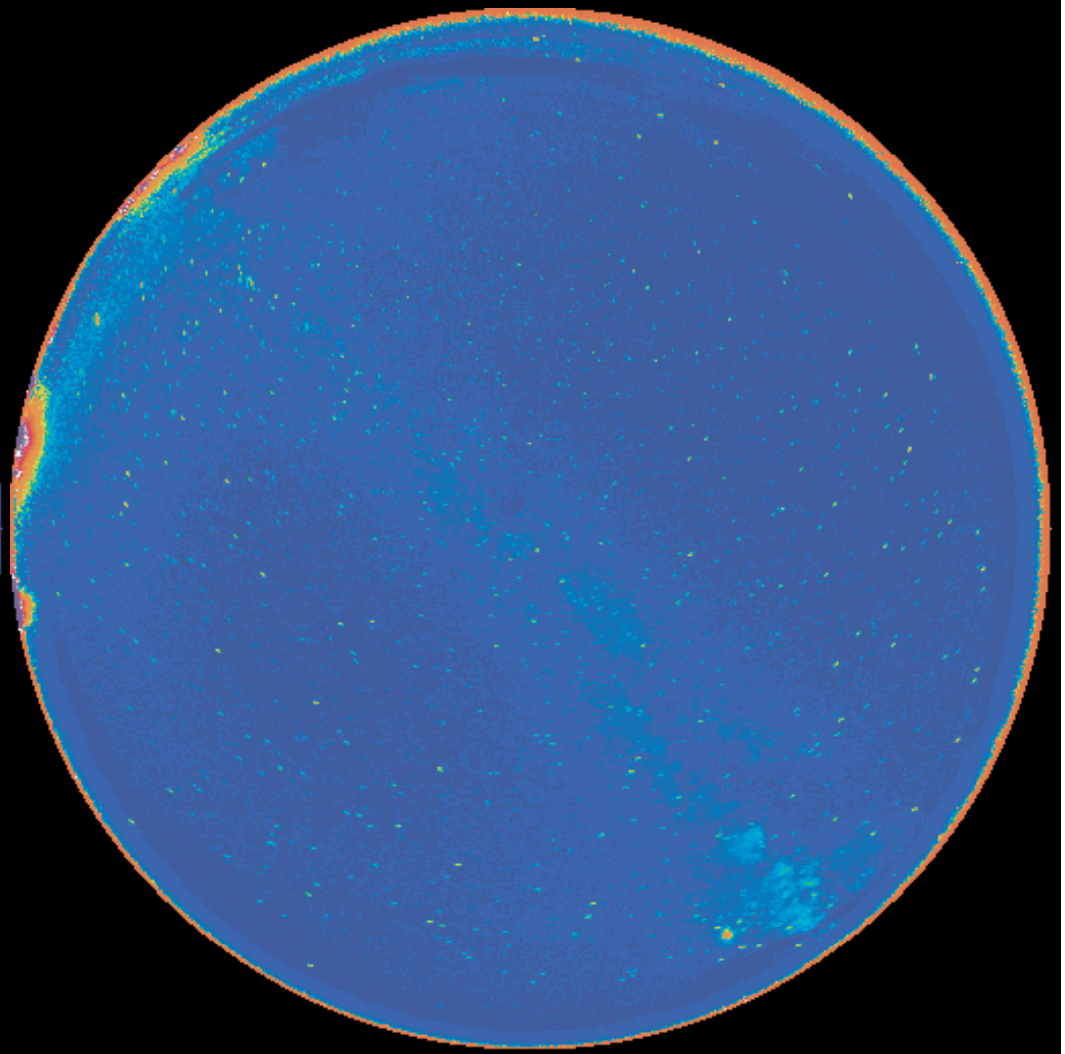


Results: 20km from Vienna / Unpolluted

Großmugl near Vienna, *mag6.2*

Pristine Sky (Mongolia) ***mag6.3***





Vienna

Results: 20km from Vienna / Unpolluted

Großmugl near Vienna, *mag6.2*

Pristine Sky (Mongolia) ***mag6.3***

A Rare View: Dark Clouds at Night!

Astronomy Day, 2008-05-10, Großmugl

2 illuminated roads

Astronomy Day, 2008-05-10, Großmugl

1 illuminated road

Astronomy Day, 2008-05-10, Großmugl

Lights off

Astronomy Day, 2008-05-10, Großmugl

Großmugl

Lights off

Vienna

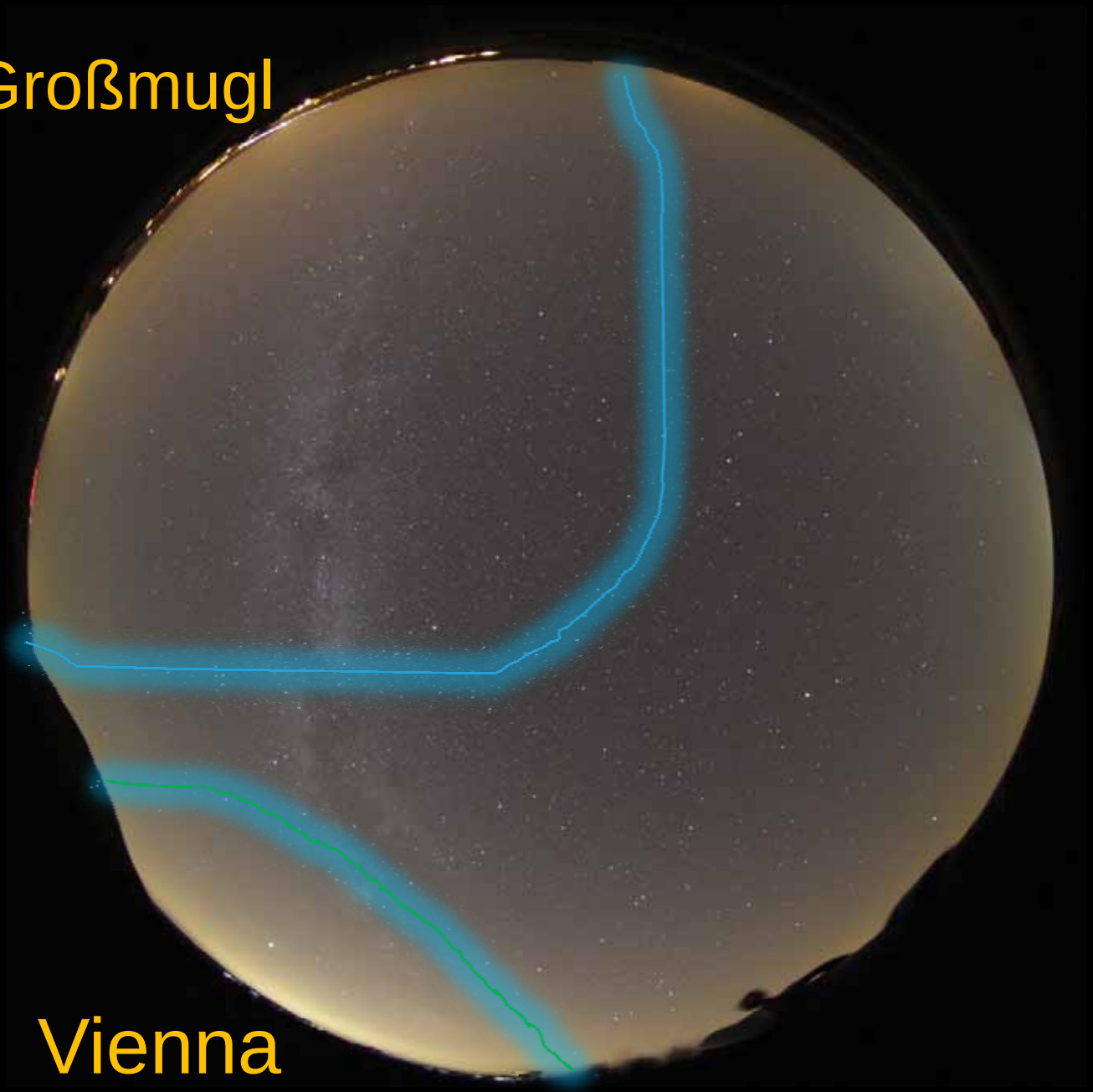
Astronomy Day, 2008-05-10, Großmugl

1 illuminated road,
10 minutes after power-on

Astronomy Day, 2008-05-10, Großmugl

Back to „normal“

Astronomy Day, 2008-05-10, Großmugl

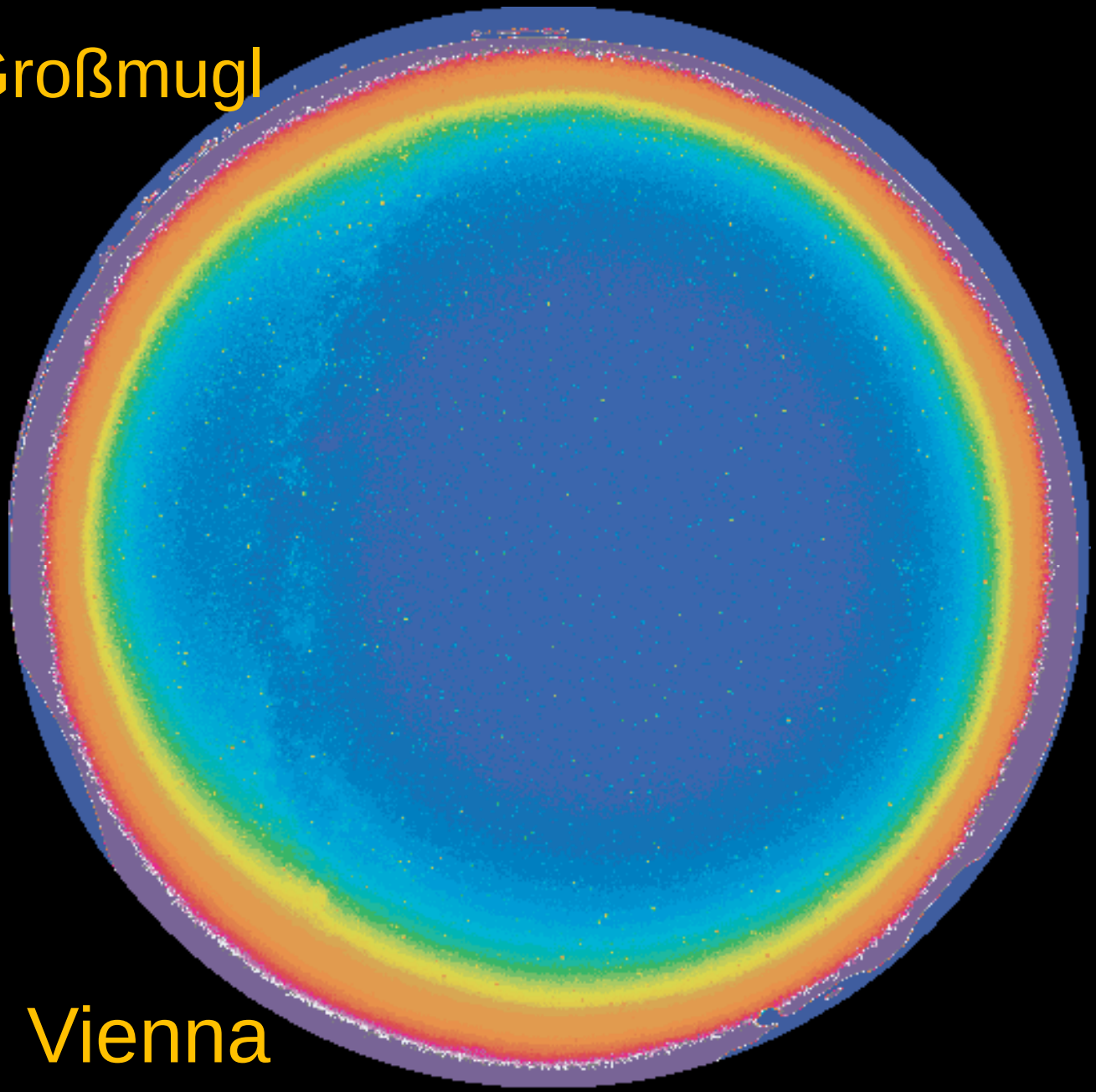


Back to „normal“

Astronomy Day, 2008-05-10, Großmugl

Großmugl

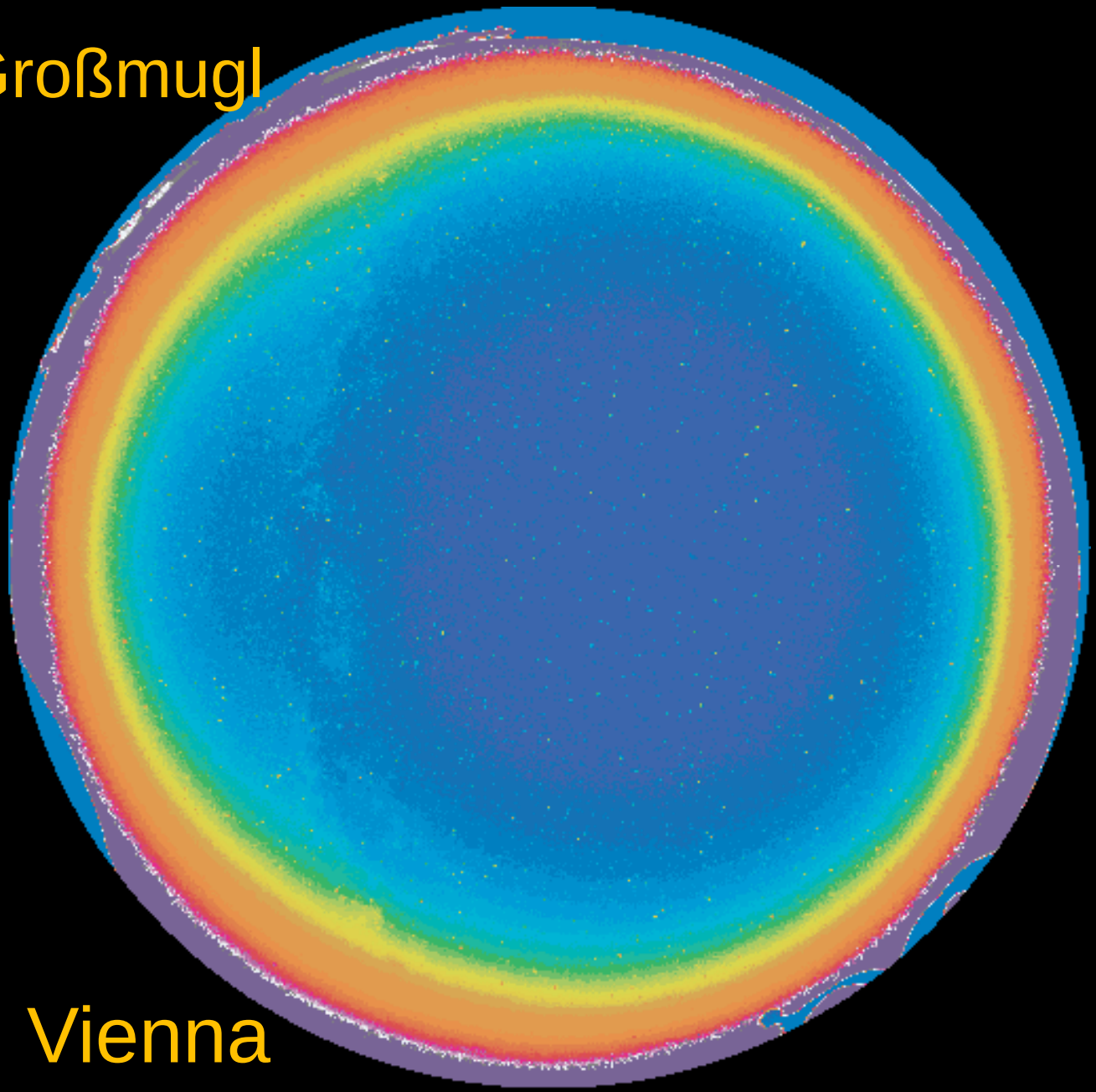
Lights off



Vienna

Astronomy Day, 2008-05-10, Großmugl

Großmugl



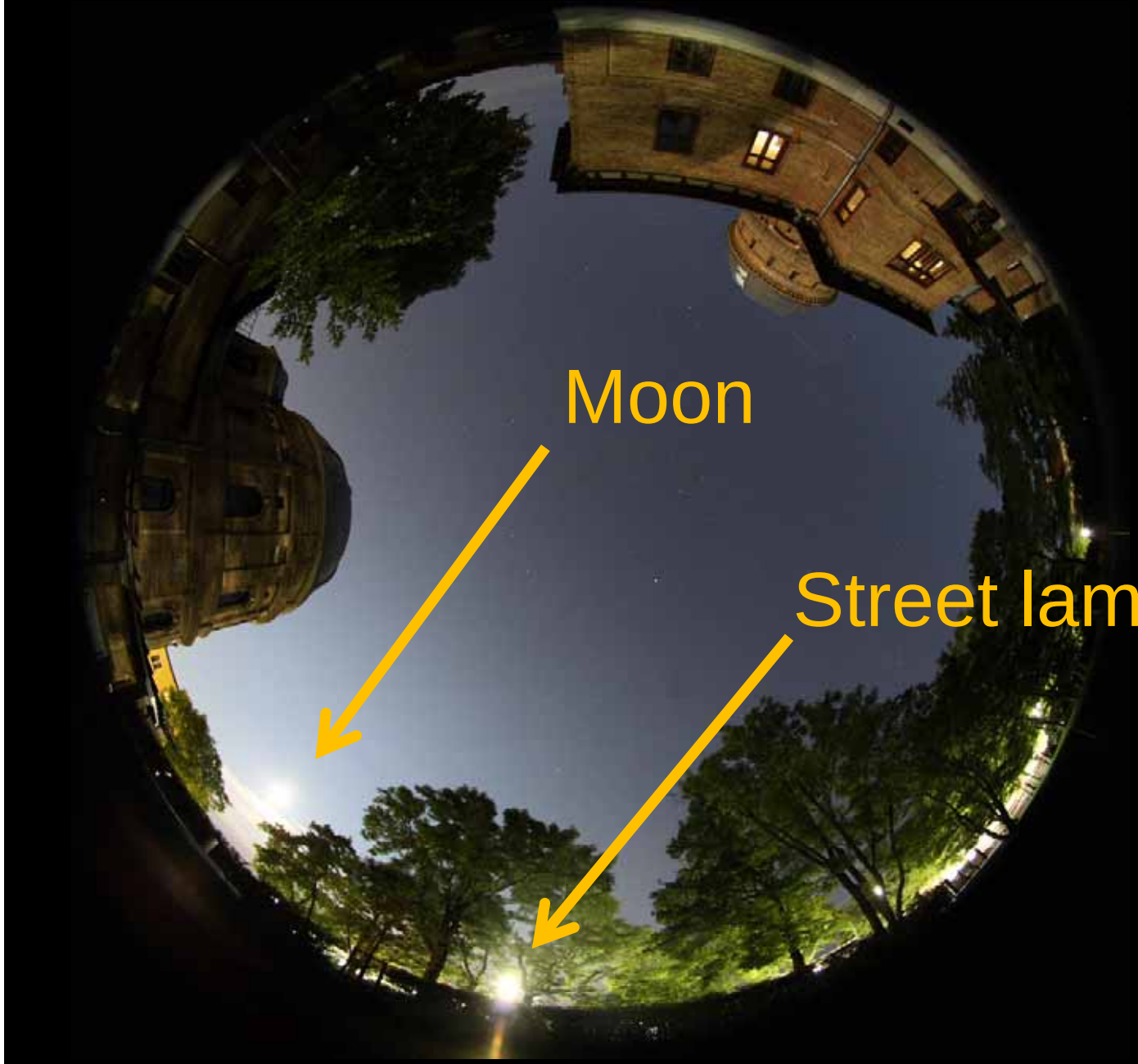
Vienna

Back to „normal“

Open Questions

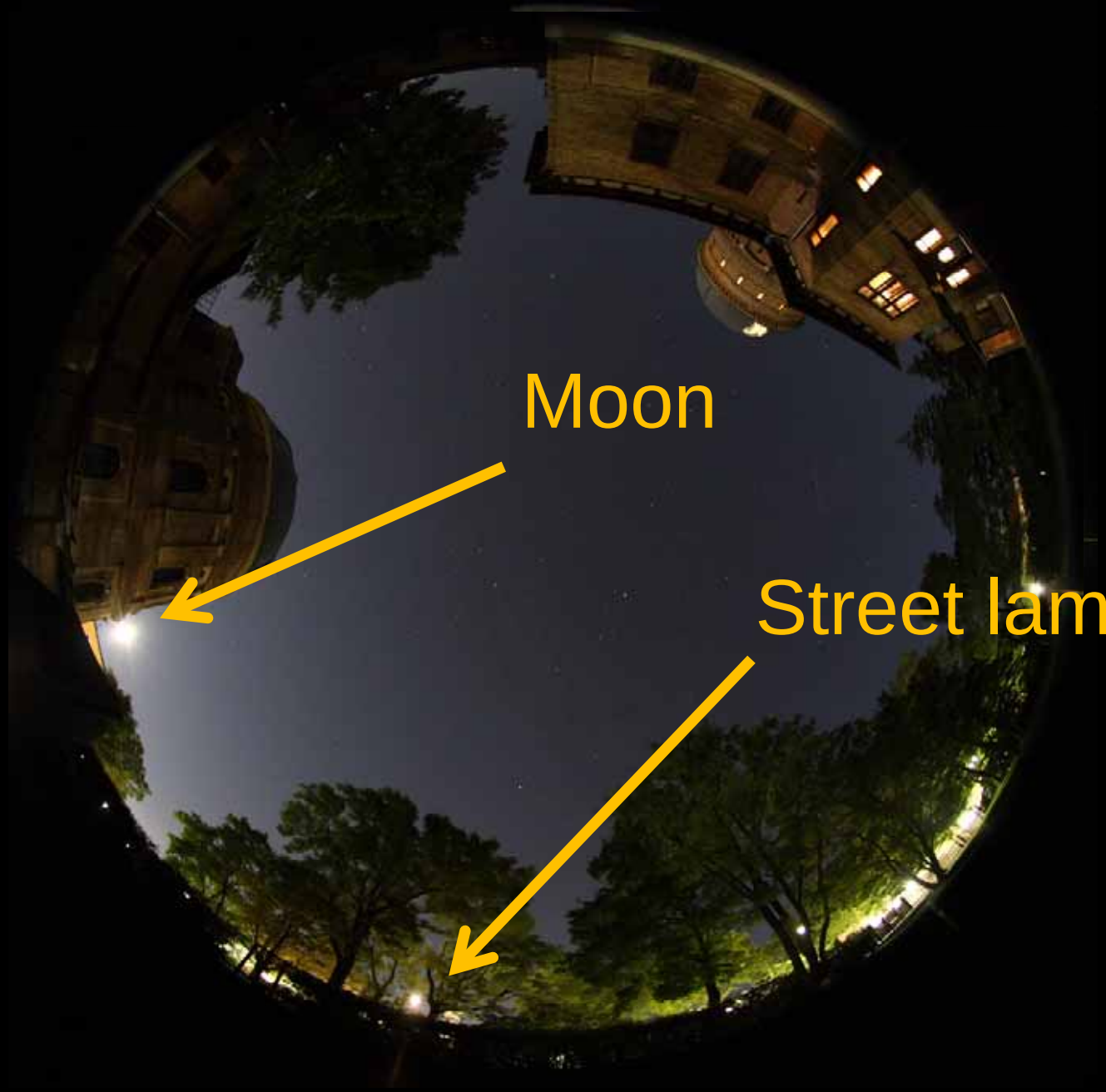
- Calibration:
  - Reference photometer not sensitive enough for dark scene
  - SQM sensitivity non-photopic
  - SQM (older model) field of view difficult
- What is the „best“ sky brightness unit?
  - cd/m²
  - mag/arcsec²
  - Limiting visual magnitude
- Can we agree on a common colour scale?

Street Luminaires at Kuffner Observatory



Last Sunday

Street Luminaires at Kuffner Observatory



Tuesday

Street Luminaires at Kuffner Observatory

Street Luminaires at Kuffner Observatory

Conclusions

- All-Sky Luminance Measurement System
  - Calibrated HDR Imaging System
  - Simple extensions to PFS Tools

  →False-Colour Plots
    - For “technical” astronomers: mag/arcsec²
    - For visual star watching: limiting visual magnitudes
    - PFS base units: cd/m²
- Light Pollution in rural areas ruins esp. horizon sky
- Effect of road light reduction clearly visible

Thank you for Your Attention

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