



INTERNATIONAL  
YEAR OF LIGHT  
2015

**COSMIC  
LIGHT** IAU

Globe at Night - Sky  
Brightness Monitoring  
Network

User Workshop Tokyo, Japan - Jan 7-9, 2015

## Project background

# The Globe at Night - Sky Brightness Monitoring Network

Dr Jason Chun-Shing PUN (潘振聲),  
Dr Chu-Wing SO & Ryan W.Y. LEUNG,  
The University of Hong Kong



国立天文台  
**NAOJ**  
National Astronomical  
Observatory of Japan



# The Globe at Night - Sky Brightness Monitoring Network

- The **Globe at Night** program (<http://www.globeatnight.org/>)
  - an international citizen-science campaign to raise public awareness of the impact of light pollution
  - inviting citizen-scientists to measure their night sky brightness and submit their observations from a computer or smart phone



# The Globe at Night - Sky Brightness Monitoring Network

- **The Globe at Night - Sky Brightness Monitoring Network project**
  - Our team has been studying light pollution in Hong Kong by through measuring the night sky brightness (NSB) since 2003.
  - We conducted a citizen-science NSB measurement campaign between 2007 – 2009.
  - It was succeeded by a comprehensive NSB monitoring network in 2010 (NSN, Please refer to Dr So's talk)
  - This project was initiated as a University of Hong Kong Knowledge Exchange (KE) program **“Promoting light pollution education and research worldwide”**

# The Globe at Night - Sky Brightness Monitoring Network

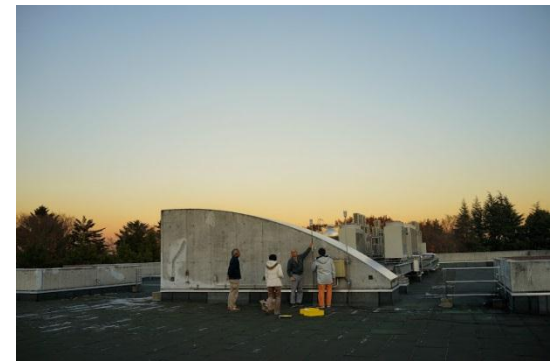
- **The Globe at Night - Sky Brightness Monitoring Network project**
  - Endorsed by the IAU Executive Committee Working Group for the IYL as a major Cosmic Light program
  - In the award letter from IAU, it states “**Suggestions were to coordinate ... with others who are pursuing the educational aspect in other regions.**”
  - Built on the successful Globe at Night participation model, we hope to establish a worldwide night sky brightness monitoring network (NSN).

# The Globe at Night - Sky Brightness Monitoring Network

- **The Globe at Night - Sky Brightness Monitoring Network project**
  - Partners (a quickly expanding list):
    - IAU Office for Astronomy Outreach,
    - National Astronomical Observatory of Japan (NAOJ),
    - HKU,
    - Globe at Night,
    - Ho Koon Nature Education cum Astronomical Centre,
    - .....
- Project website: <http://globeatnight-network.org/>

# The Globe at Night - Sky Brightness Monitoring Network

- **The Globe at Night - Sky Brightness Monitoring Network program**
  - Set up a global night sky brightness monitoring network using the commercial available meter SQM-LE for long term monitoring of light pollution.
  - A real time map of light pollution available on the project website.





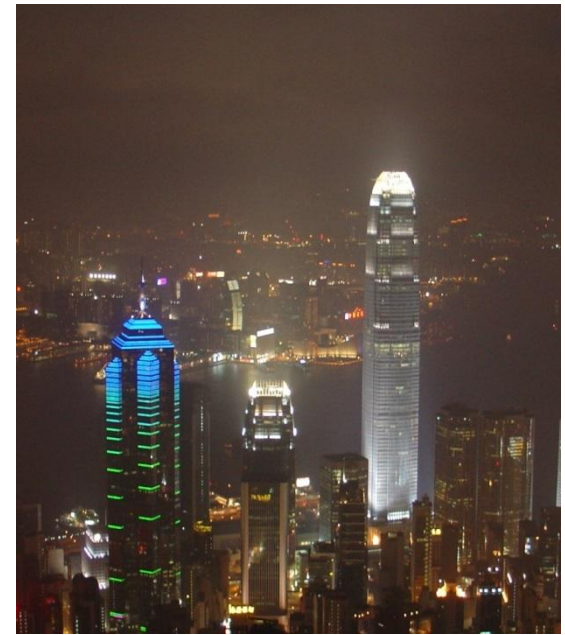
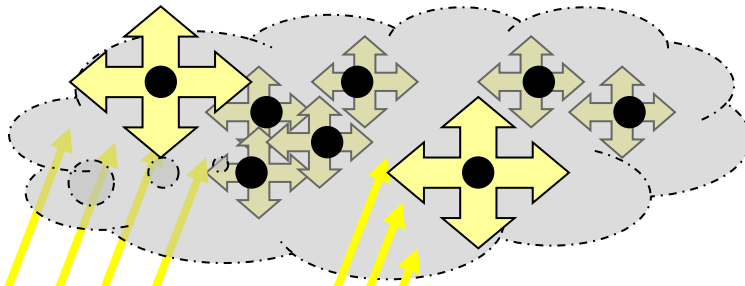
# The Globe at Night - Sky Brightness Monitoring Network

- **Target groups**

1. **Astronomical community**: Professionals, amateurs, planetarium and observatory staff
2. **Environmental community**: Ecological professionals (e.g. specialists on insects, birds, nocturnal marine species, etc), environmental enthusiasts, environmental advocates
3. **Education community**: students and teachers of astronomy, planetary science, and environmental science
4. **General public**: government officials, policy makers, opinion leaders, citizen-scientists

# Light pollution

- Light Pollution is the improper use of artificial outdoor lightings which leads to adverse effects on the environment.
- Wasteful light emitted upwards directly by or reflected from artificial sources being scattered by aerosol (cloud, fog), or pollutants like suspended particulates in the atmosphere.





# The Earth at Night (2012)



Image courtesy of NASA Earth Observatory/NOAA NGDC

# The Earth at Night – Hong Kong (2012)

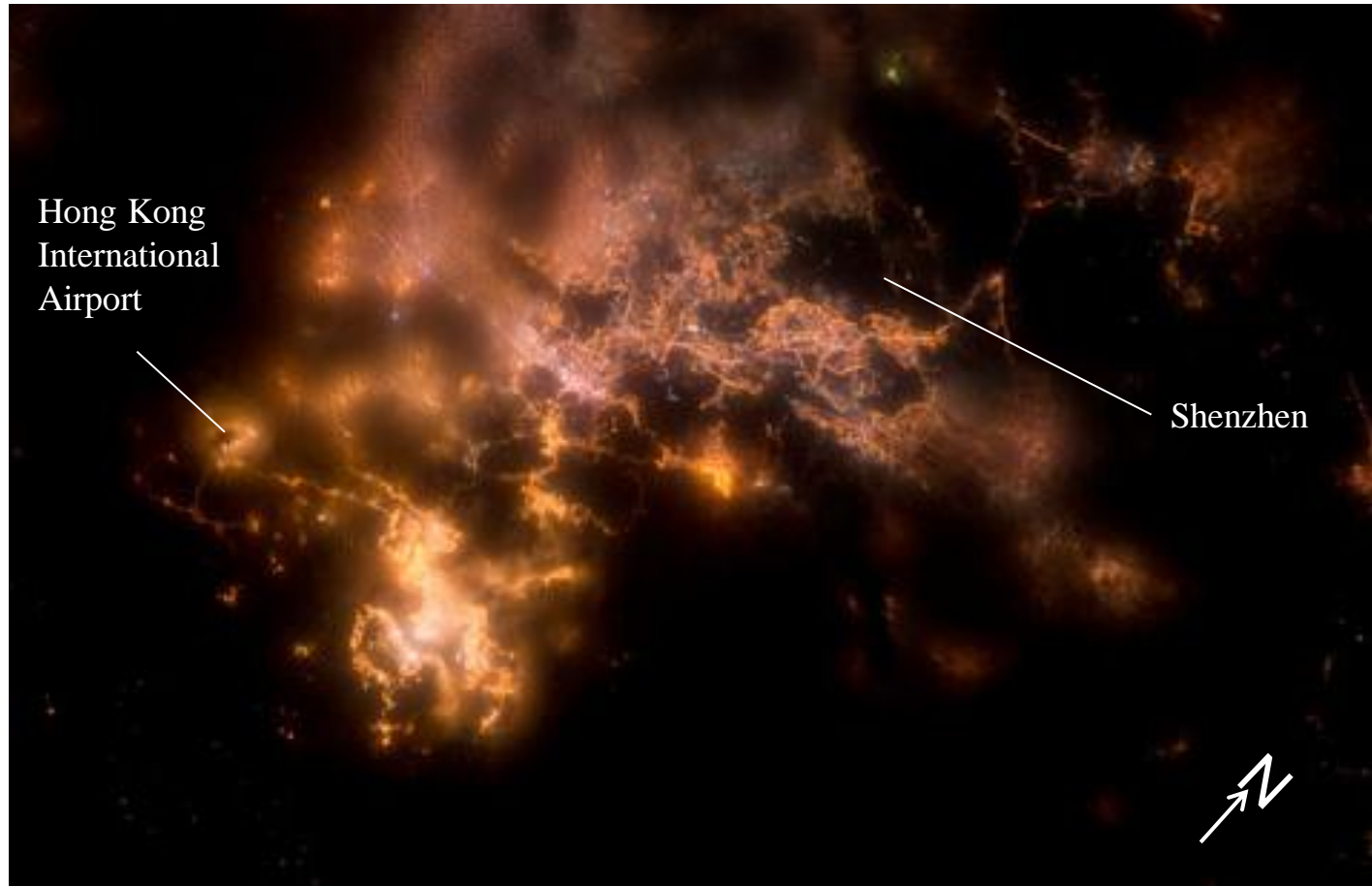


Image courtesy of Image Science and Analysis Laboratory, NASA-Johnson Space Center, The Gateway to Astronaut Photography of Earth

# The Earth at Night – Taiwan (2014)



Image courtesy of Image Science and Analysis Laboratory, NASA-Johnson Space Center, The Gateway to Astronaut Photography of Earth



# The Earth at Night – Taipei (2012)

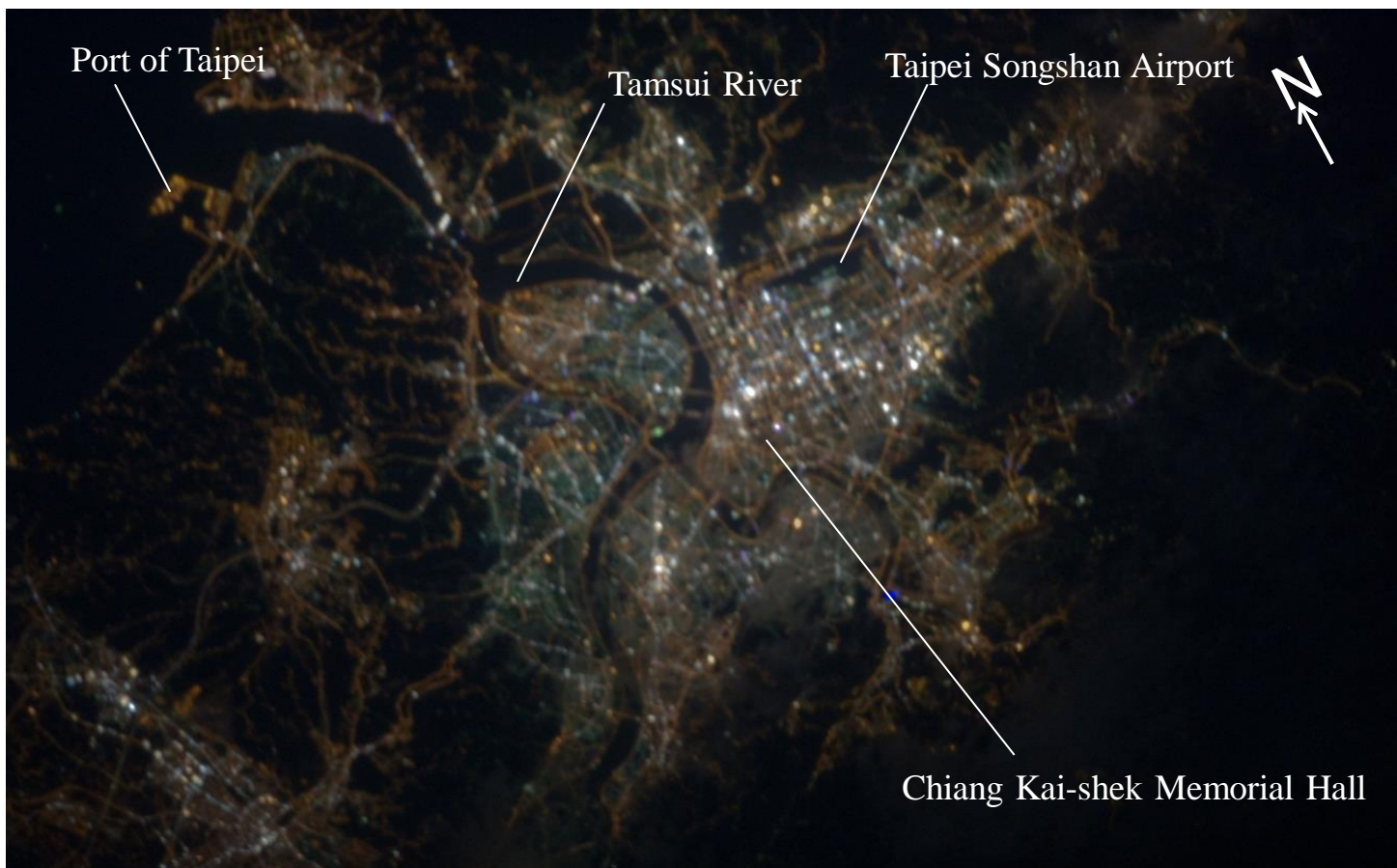


Image courtesy of Image Science and Analysis Laboratory, NASA-Johnson Space Center, The Gateway to Astronaut Photography of Earth

# The Earth at Night – Korea (2014)



Image courtesy of Image Science and Analysis Laboratory, NASA-Johnson Space Center, The Gateway to Astronaut Photography of Earth



# The Earth at Night – Seoul (2004)



Image courtesy of Image Science and Analysis Laboratory, NASA-Johnson Space Center, The Gateway to Astronaut Photography of Earth

# The Earth at Night – Manila (2003)

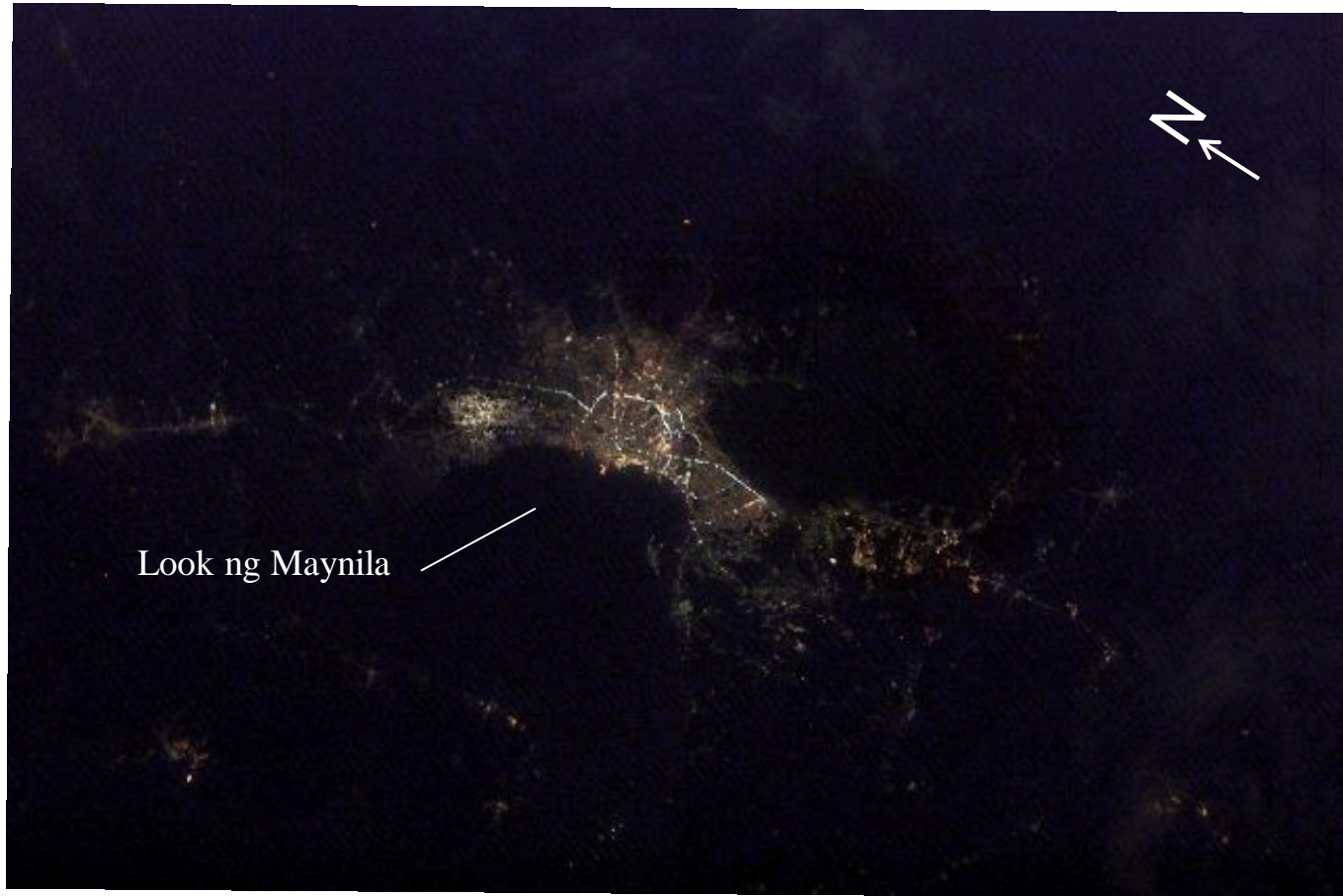


Image courtesy of Image Science and Analysis Laboratory, NASA-Johnson Space Center, The Gateway to Astronaut Photography of Earth



# The Earth at Night – Tokyo (2008)



Image courtesy of Image Science and Analysis Laboratory, NASA-Johnson Space Center, The Gateway to Astronaut Photography of Earth

# The Earth at Night – Tokyo (2008)



Image courtesy of Image Science and Analysis Laboratory, NASA-Johnson Space Center, The Gateway to Astronaut Photography of Earth

# Light pollution & Night Sky Brightness

- Adverse effects of light pollution:
  - Health: light trespass, light nuisance
  - Environmental: nocturnal species, unbalance ecological systems
  - Energy: light not targeted at your eyes → wasted energy
  - Astronomical: skyglow / “overglow” from urban lighting
- Skyglow increases the night sky brightness
  - decrease the brightness contrast of the night sky
  - reduce the number of star visible by naked eye
  - reduce the accuracy of astronomical observations



# Measuring Light Pollution

- Globe at Night (and other similar programs)
  - counting of number of stars visible in certain constellation



Some environmental pressure group in Hong Kong measures the street light level using luxmeters.

# Measuring Light Pollution

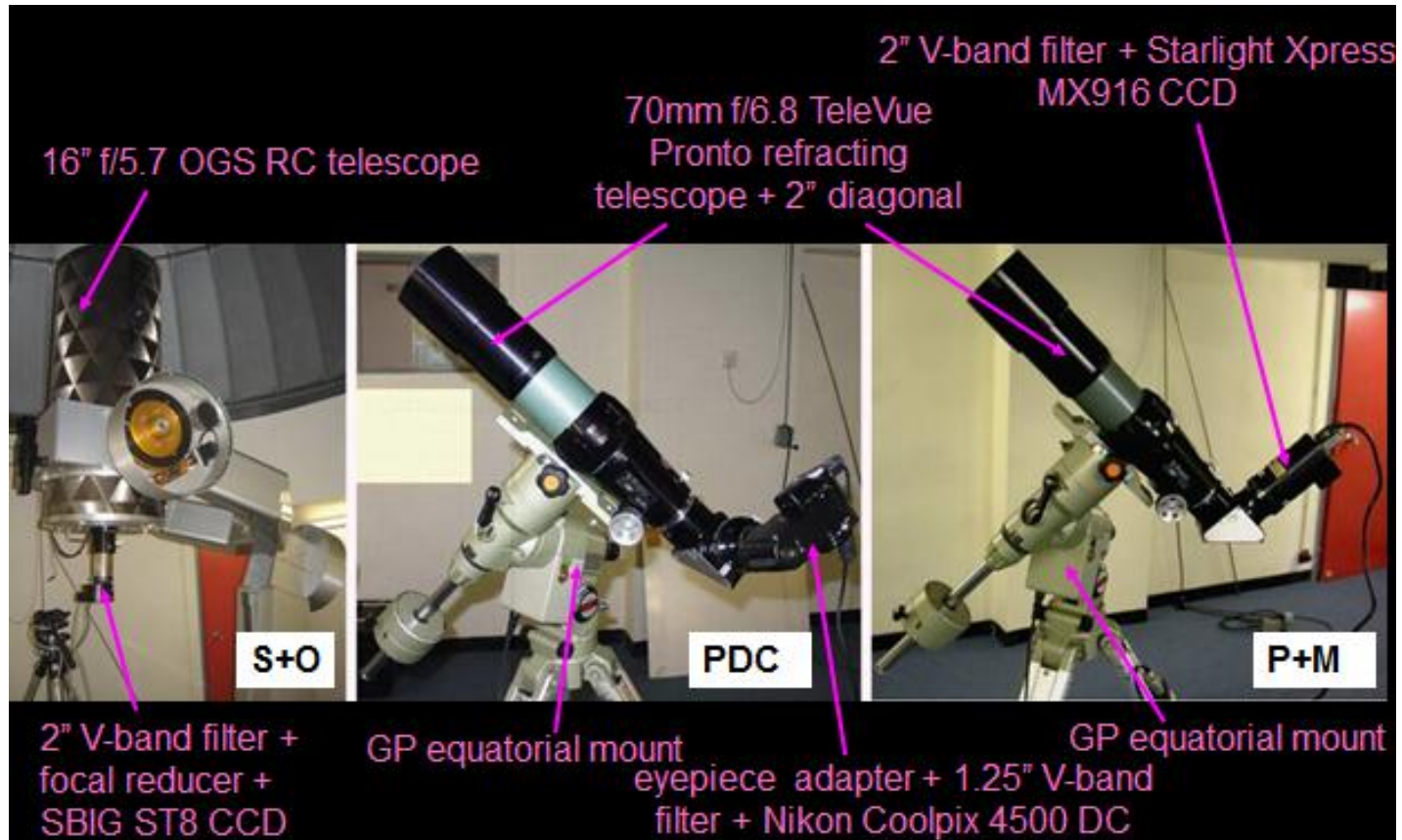
## “Star-counting” survey

- Advantages:
  - Large geographical & temporal coverages with low cost
  - Light pollution conditions near places of human activities
  - Wide spread of the dark sky conservation message
- Disadvantages:
  - Photometric error is very large ( $\pm 1.2$  mag arcsec<sup>-2</sup>) (Kyba et al. 2013)

**GaN a huge success as a citizen-science campaign**

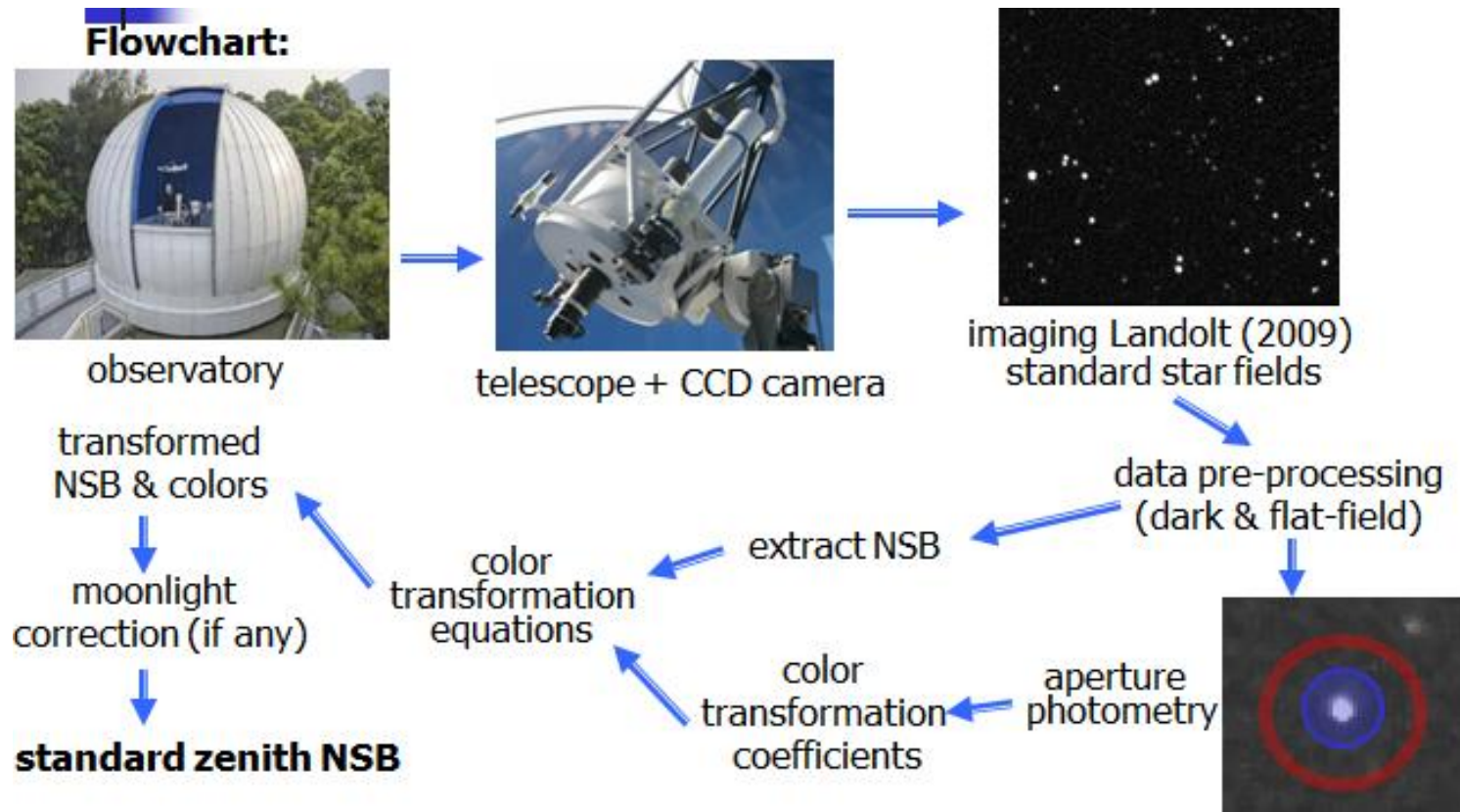
# Measuring Night Sky Brightness (NSB)

- Astronomical technique (our different settings in 2003-07)



# Measuring Night Sky Brightness (NSB)

- Astronomical technique (photometry)



# Measuring Night Sky Brightness (NSB)

## CCD photometry

- Advantages:
  - Photometric error is very small ( $<0.1 \text{ mag arcsec}^{-2}$ )
  - Multiple bands measurement (if used with a filter wheel)
  - Easy comparison with historical records
- Disadvantages:
  - High cost (trained personnel, sophisticated equipment)
  - Limited geographical & temporal coverages
  - Challenging to do in an urban setting

**A key to success is to reduce the “cost”**



# Measuring Night Sky Brightness (NSB)

- **Hand-held devices** from advancement of solid-state sensor:
  - DigiLum luminance meter, Mark Light Meter, Sky Quality Meter (SQM), etc
  - Smartphone app:



# Measuring Night Sky Brightness (NSB)

## Handheld devices

- Advantages:
  - Fairly accurate ( $\pm 0.1$  mag arcsec<sup>-2</sup>)
  - Low cost ( $\sim$ USD 300 per unit) and ease of usage
  - High data sampling frequency (several seconds)
  - Can work effectively in both urban and rural environments
- Disadvantages:
  - Single and non-standard wavelength passband (though the SQM magnitude is gaining popularity in light pollution circles)
  - Only accurate near zenith(?)

# Measuring Night Sky Brightness (NSB)

## Handheld devices

- We believe an international SQM network provides the best compromise for cost, ease-of-use, geographical coverage, and temporal monitoring.
- From personal experience: While to the public the success of the project may depend on the data quantity (minimizing the dead-time), *maintaining data quality is more important*.
- E.g., the maintenance of the equipment (meter + shielding), a uniform and scheduled calibration scheme across the project, minimize data collected with “non-night-sky” factors not documented. (More on these in Dr So’s talks)

# Let's work together to preserve our dark sky!

## Thank you!