Establishment of observational techniques for solar ultraviolet radiation over Antarctic Dome A and Beijing

南极冰穹A和北京地区太阳紫外辐射观测手段的建立与研究

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UV Radiation

- Ultraviolet (UV) radiation is electromagnetic radiation with a wavelength shorter than that of visible light, but longer than X-rays, in the range 10 nm to 400 nm.

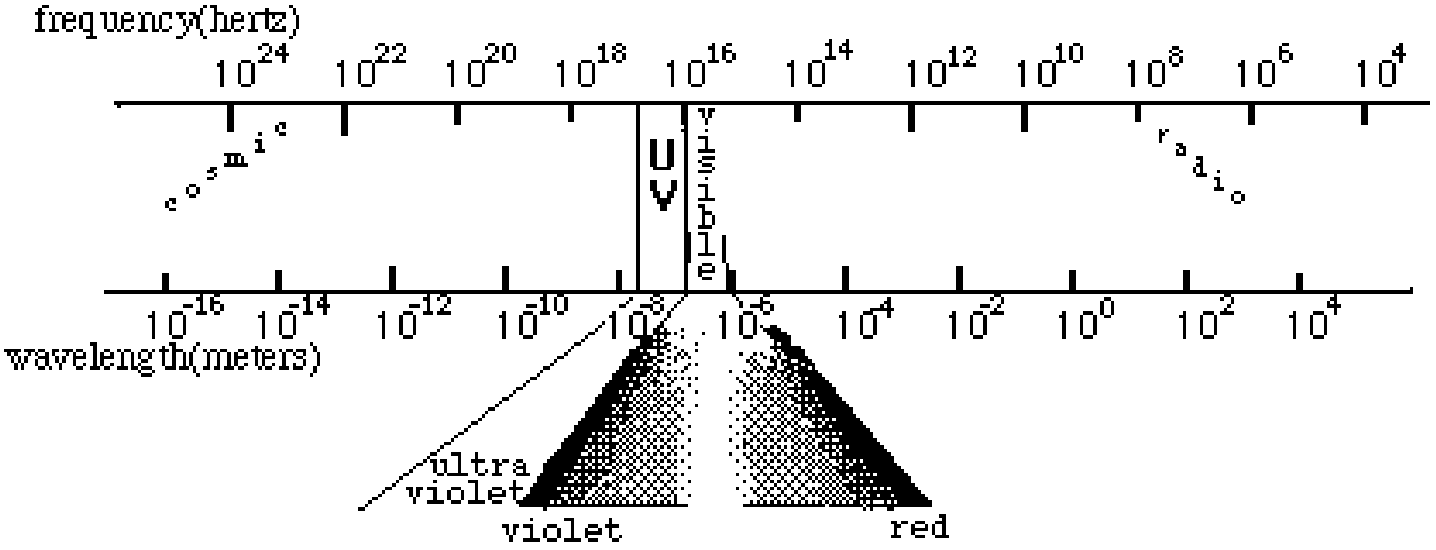


Fig.1. The electromagnetic spectrum.

Subtypes

- **UV Astronomy**

  NUV: 400-300 nm, MUV: 300-200 nm, FUV: 200-120 nm, EUV: 120-30 nm,

  XUV: 30-1 nm.

- **Solar UV radiation**

  UVA: 400-315 nm, UVB: 315-280 nm, UVC: 280-200 nm, VUV: <200 nm

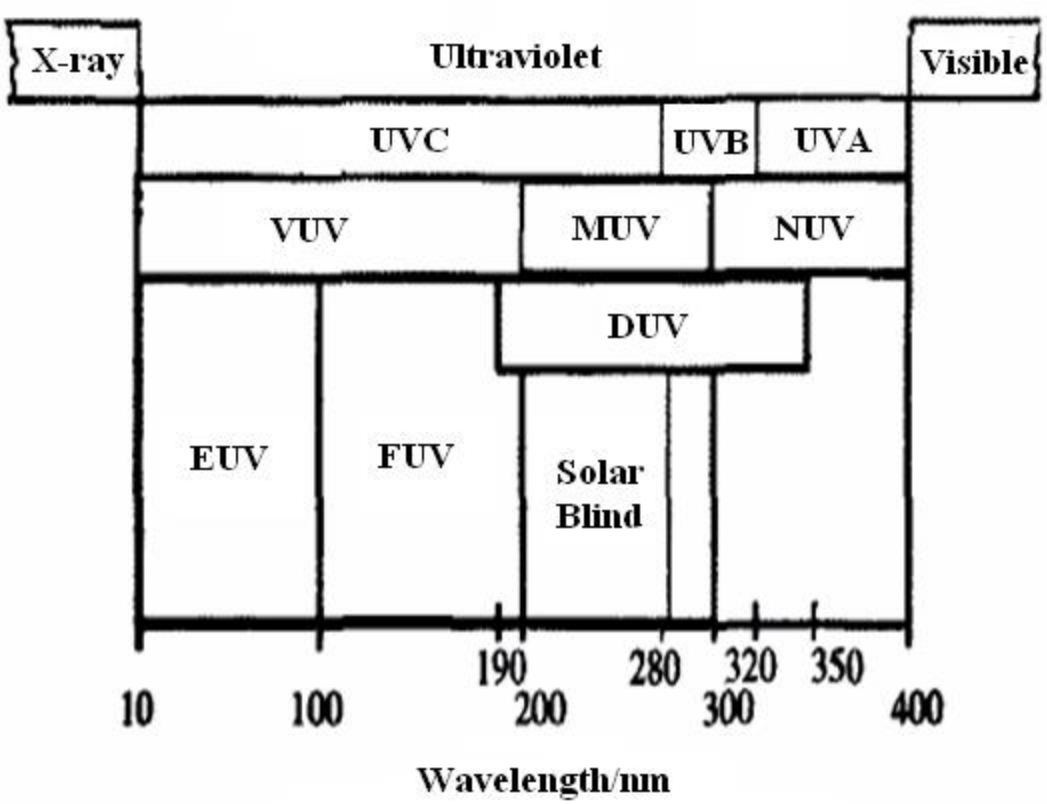


Fig.2. Subtypes of UV radiation.

Solar UV radiation at ground surface

As sunlight passes through the atmosphere, all UVC and approximately 90% of UVB radiation are absorbed by ozone, water vapour, oxygen and carbon dioxide. UVA radiation is less affected by the atmosphere.

- UVB (280~315 nm)
  - Vitamin D, calcium
  - Ecological, environmental and climate effect
  - Skin cancers and cataracts
- UVA (315~400 nm)
  - Sunburn and tanning

Significance

- ✓ Solar UV radiation and climate
- ✓ Solar UV radiation and ecological environment

- ➢ UV radiation intensity forecasting
- ➢ Measurement of atmospheric ozone
- ➢ Long-term variation law of UV radiation
- ➢ Characteristics of UV radiation against time
- ➢ Provide the important scientific basis for evaluation and assessment of ecological and environmental effects

- ✓ Solar UV radiation and solar activity
- ✓ Sunspots, solar flare, coronal mass ejections (CMEs)

- ➢ Observational features of the fast activities of solar UV radiation
- ➢ Characteristics of UV spectral distribution during solar activity
- ➢ Response of UV radiation at ground surface to solar activity

- ✓ Site testing for Dome A

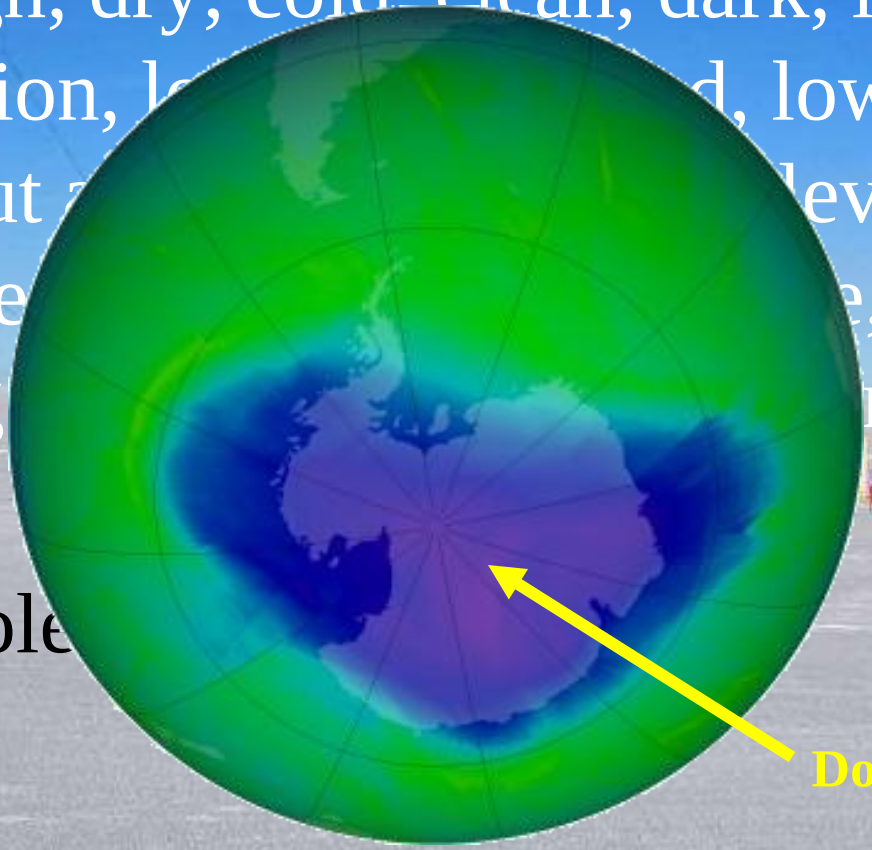
- ➢ Atmospheric UV transmissivity
- ➢ UV Astronomy

Objectives

- The development of special UV radiometer for all-weather conditions
  - Antarctic Dome A, Beijing
- A fast and sensitive measuring system for UV spectra based on multi-anode photomultiplier tube assembly

Dome A，January 2010

- Clear, high, dry, cold, clean, dark, low precipitation, l d, low wind throughout a level turbulence e, continuous observing no lightning,
- Ozone Hole

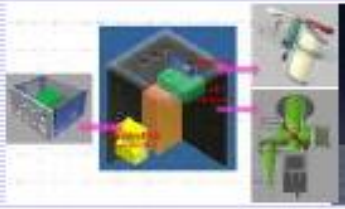


Dome A Observatory Development: A Roadmap

2006-2008 — Site Survey & Small Telescope



2009-2011 — +Site Testing & Middle-size Telescope




2011-2015 — Dome A Observatory Phase I


2.5m Opt/NIR
KDUST


5m THz
DATE5

2016-2025 — Dome A Observatory Phase II


6-8m
Opt/NIR


15m THz

Research contents

- Instrument design
  - UVA、UVB irradiance and spectral distribution
  - Long-term observation： all-weather conditions
  - Dome A： low temperature, low pressure……
- Performance test
  - Laboratory simulation test
  - Ali, northeast China…

Instruments

- Wide-band UVA/UVB radiometer

  UV enhanced silicon photodiode

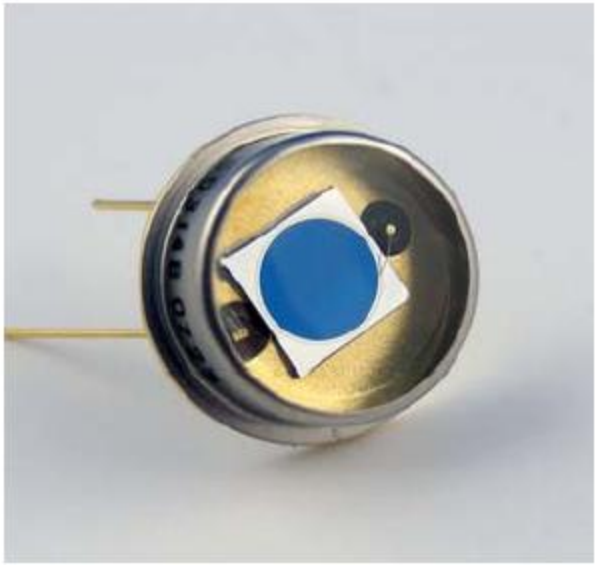


Fig.5. UV enhanced silicon photodiode

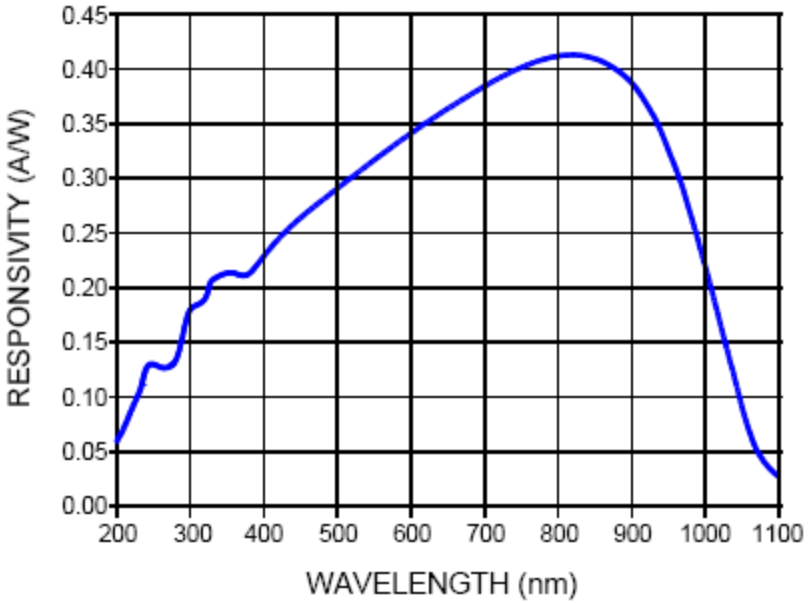


Fig.6. Typical spectral response

➢ UV spectral measuring system

Multi-anode photomultiplier tube assembly

Fig.7. Linear array multi-anode PMT assembly, 8-channel, 16-channel and 32-channel.

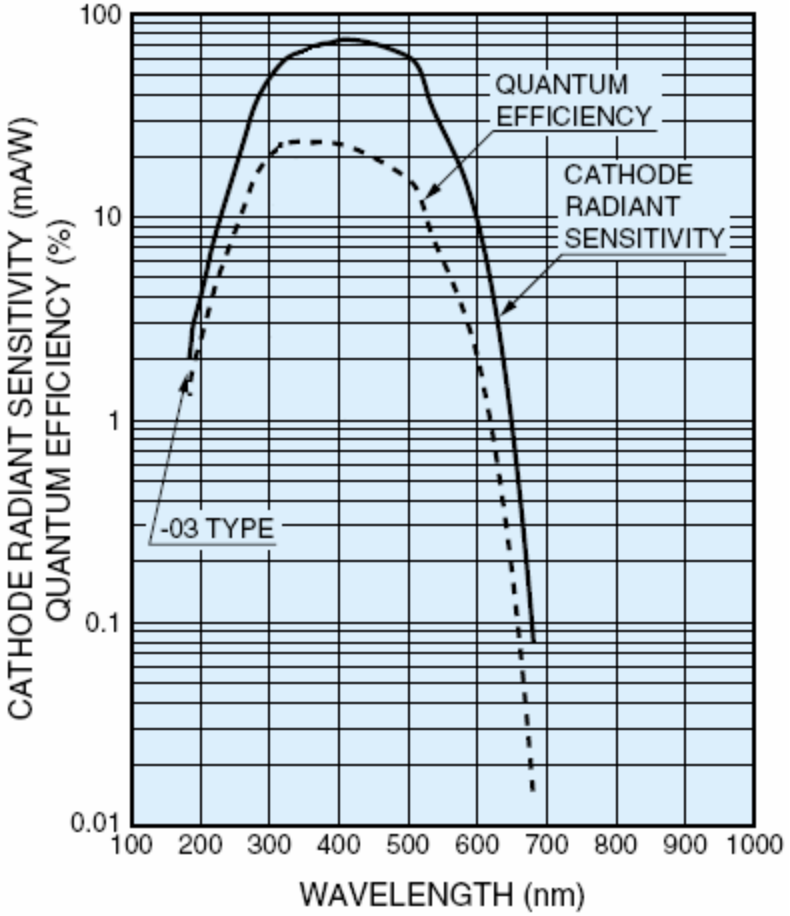


Fig.8. Typical spectral response.

Key problems to be solved

- ✓ Low temperature

  Dome A: -83℃~-15℃, mean: -58℃

- ✓ All-weather conditions

  Sunny, rainy, snowy, cloudy,……

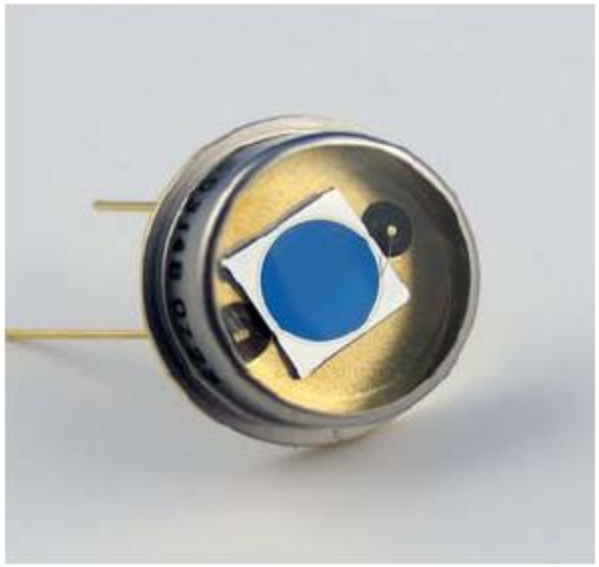
  Wide range change of temperature

- ➢ Heating thermostat
  - ➢ The normal working temperature is reached
  - ➢ Stable sensitivity

- ✓ Great difference in temperature between the laboratory and Antarctica
- ➢ Optical components and material with low thermal expansion coefficient

- ✓ Waterproof, moisture-resistant features
- ✓ Snow removal
- ✓ Frost melting
- ✓ ……

UVA/UVB radiometer



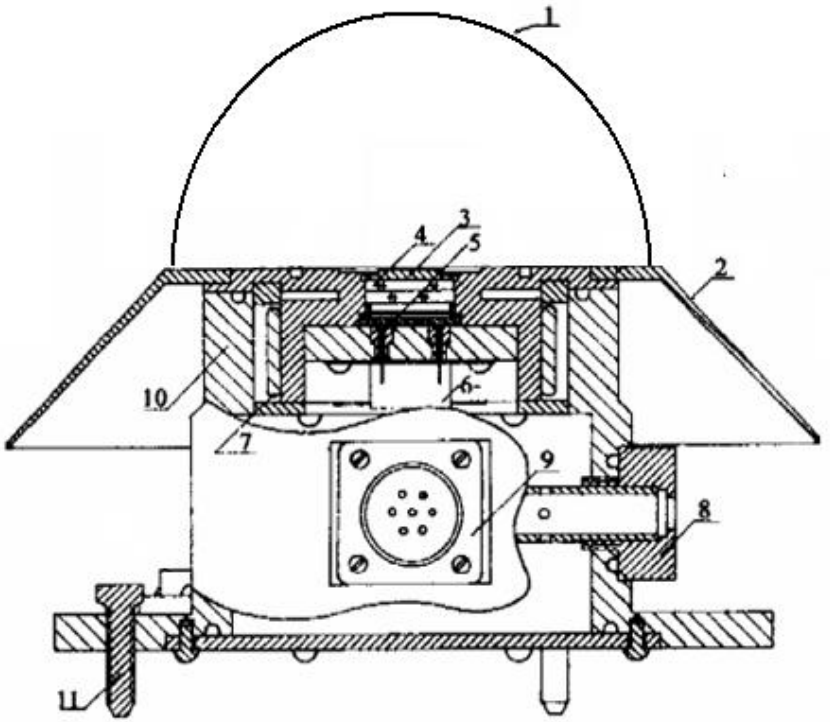


Fig.9. The structure schematic diagram of UV radiometer. 1-quartz shield, 2-sunscreen, 3-cosine corrector, 4-UV band-pass filters, 5-UV photodiode, 6-the thermostat, 7-heating ring, 8-silastic rod, 9-the electric outlet, 10-the mental shell, 11-the plane adjustment.

UV spectral measuring system

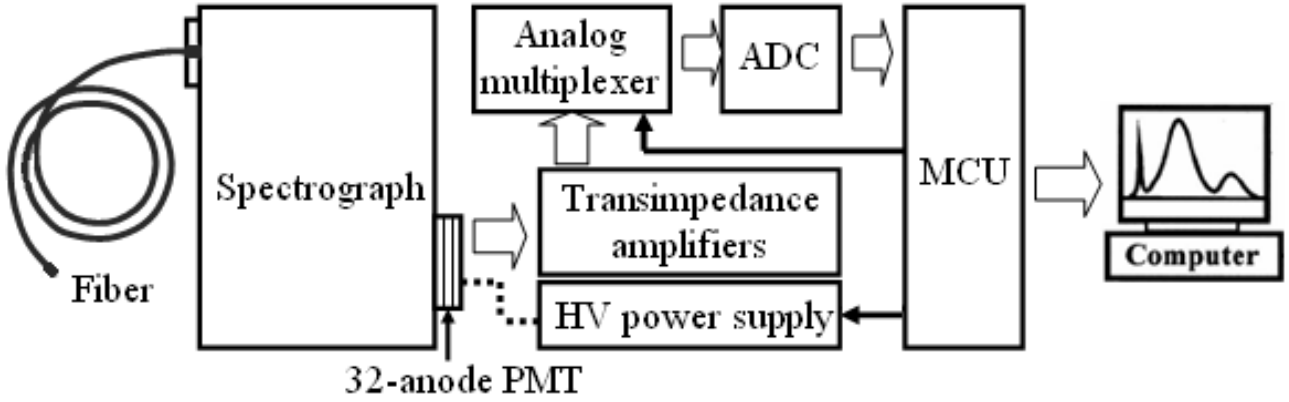


Fig. 10. The schematic of the UV spectral measuring system.

- High speed
- High sensitivity

Summary

- Solar UV radiation monitoring over Antarctic Dome A and Beijing
- The development of special UV radiometer for all-weather conditions
- A fast and sensitive measuring system for UV spectra based on multi-anode photomultiplier tube assembly
- Test observations in Ali

THANKS

FOR YOUR ATTENTION!