

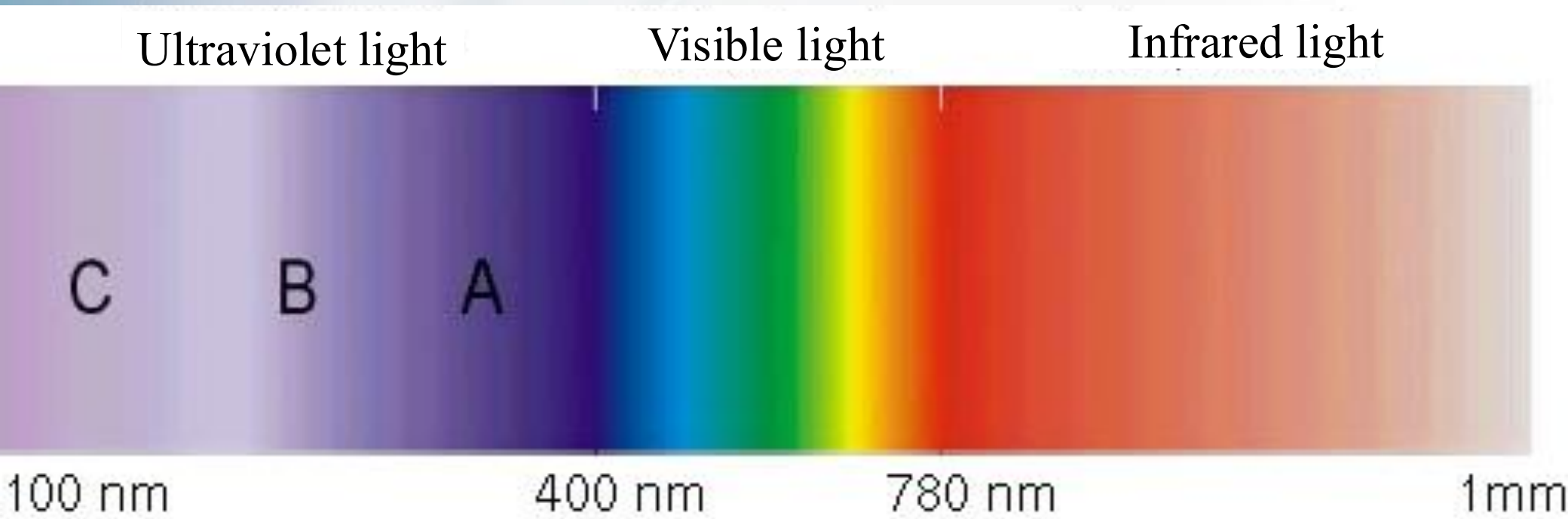
FIFTY SHADES OF ... not grey, but TWILIGHT!

Jyrki Manninen, adj.prof., PhD, deputy director
Sodankylä Geophysical Observatory

Light – what is it?

- Light is electromagnetic radiation and basically same natural phenomenon as
 - ✓ X rays,
 - ✓ the micro waves that are used to heat your porridge or
 - ✓ radio waves received by different antennas.
- Light means also that you are able to see something.
- Technically light means oscillating wave motion that is propagating with 300 000 km/s
- Light consists of small energy packets, light quantum, i.e., photons.
- Light is actually a particle like electron. Electrons are oscillating, too.
 - ✓ However, photon does not have a mass.
 - ✓ It is pure energy.

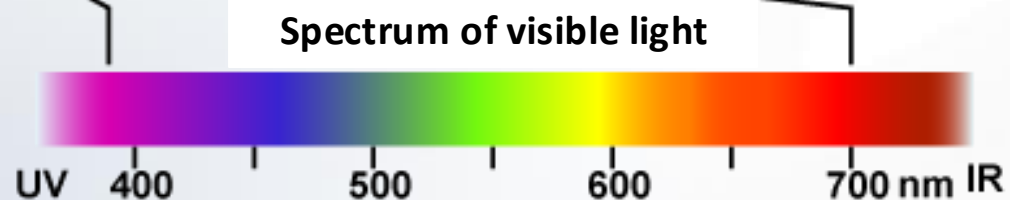
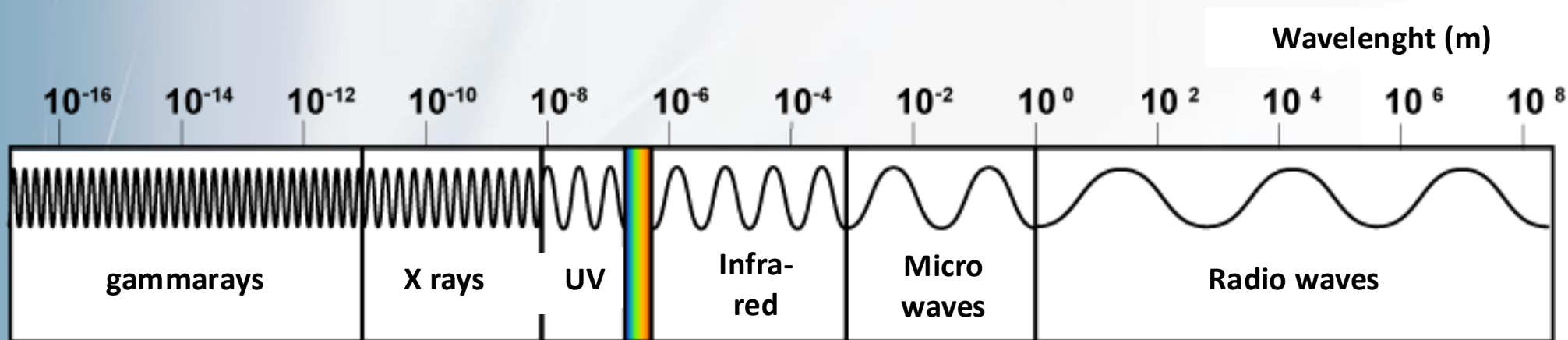
Light: Spectrum 1/2





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Radio waves: Spectrum 2/2





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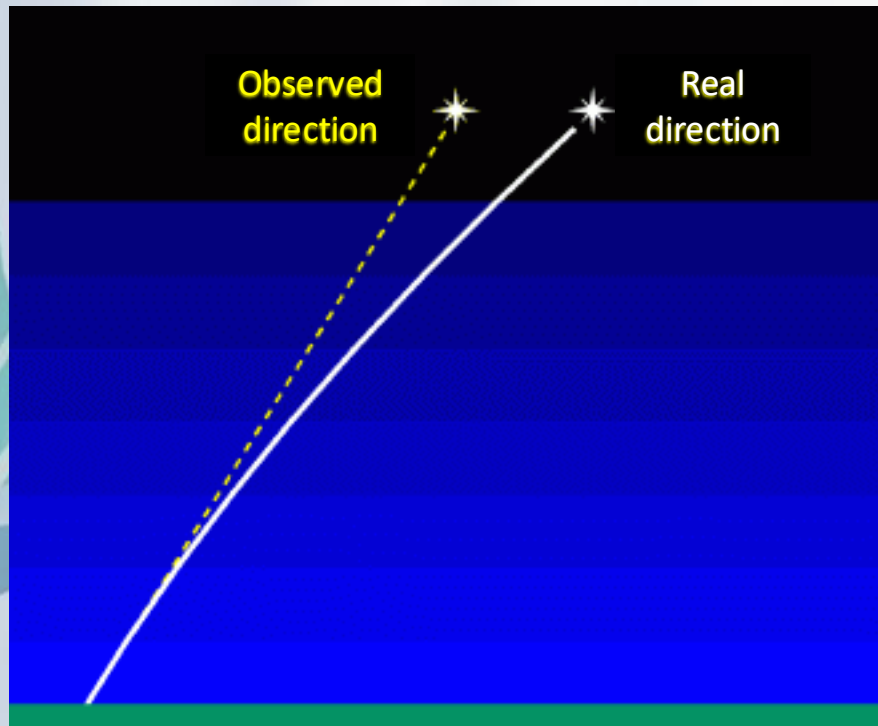
Refraction of light



Refraction of light

Due to refraction of light in the atmosphere the apparent location of the target is changing based on thickness, pressure, temperature of air, etc.

Exact determination of refraction is very difficult because it requires information about atmospheric conditions along the whole path of the light.

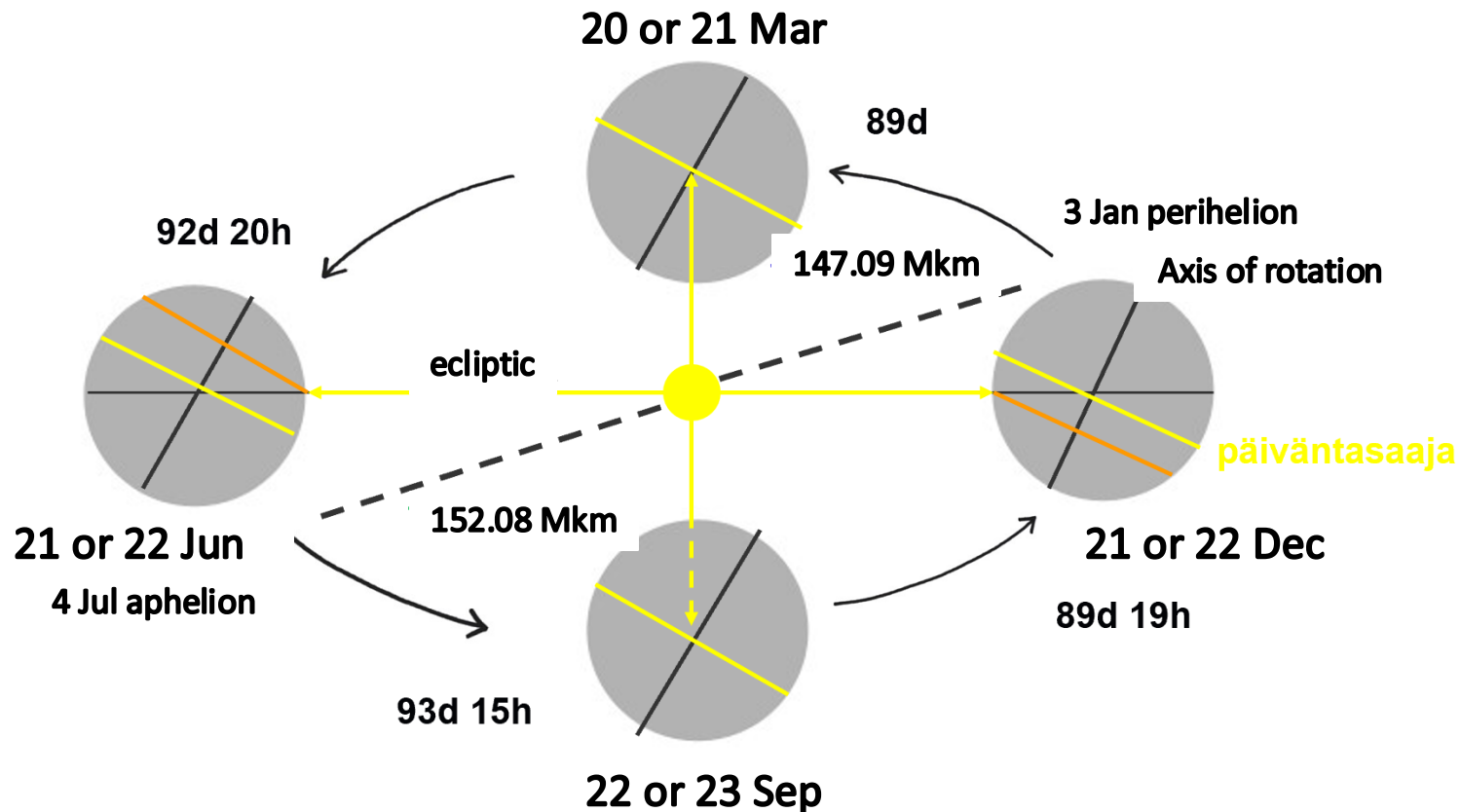


Refraction increases always the altitude of the target. Near the horizon the change is about $35'$ (arc minutes) ~ 0.6 deg. This **horizon refraction** is a bit more than the diameter of Sun. So, when we see that the lower edge of the Sun is just touching horizon, the Sun is fully below the horizon.

Remember this when speaking about polar night and mid-night sun!

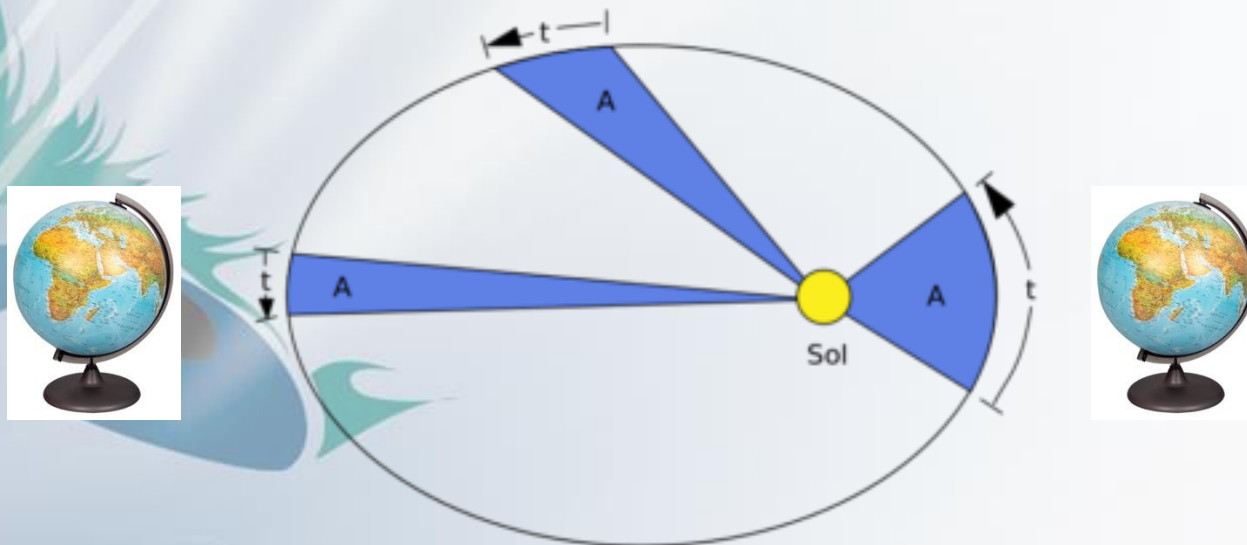
Midnight Sun – special feature of polar region

- We have midnight Sun due to the angle ($\sim 23.5^\circ$) of the axis of rotation of the Earth vs the orbital plane.



Midnight Sun – speciality of arctic (N and S)

- During summer solstice the daylight is longest, and the border of midnight Sun is located roughly from Kemi to Kuusamo.
- Figure below shows, why our winter on northern hemisphere is shorter than summer.



Duration of midnight Sun at different places

Place	Begin	End	Duration (d)
Nuorgam	16 May	29 Jul	74
Kilpisjärvi	21 May	23 Jul	63
Ivalo	23 May	20 Jul	58
Muonio	28 May	17 Jul	50
Kittilä	30 May	15 Jul	47
Sodankylä	30 May	13 Jul	45
Rovaniemi	7 Jun	6 Jul	29

Exact dates can vary during the leap year, but durations in days stay same.

Refraction of light in the atmosphere

- If there is not refraction in the atmosphere, the midnight Sun (summer) and polar night (winter) would be observed on the northern side of the Arctic Circle.
- Due to refraction of light in the atmosphere, in the morning we see whole Sun, although it is still below the horizon.
- Because the angle diameter of the Sun is about $0,5^\circ$, the Sun can be seen $0,75^\circ$ more south during summer (more north during winter) than without refraction.
 - Latitude of the Arctic Circle is $66,5^\circ$, so midnight Sun can still be seen at latitude of about $65,75^\circ$ (Kemi – Kuusamo)
 - Correspondingly, the border of polar night is at latitude of about $67,25^\circ$ (Kolari - Sodankylä – Savukoski)

Polar night – What is that?

- Period of time, when the Sun is not rising above horizon.
- Theoretically exists on the poleward of the Arctic Circle. In reality the border is about $0,75^{\circ}$ poleward in latitude.
- The southern border of polar night is between Sodankylä Geophysical Observatory and Sodankylä centre.
- In Finland the longest polar night is at Nuorgam that is the northernmost place in Utsjoki and Finland. There the polar night begins 24–25 Nov and ends 17–18 Jan. Dates are varying in different years. So, polar night is lasting more than 50 days.



Polar night



Midnight Sun

Sodankylä Ge



Arctic Circle

Phases of twilight





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Other light phenomena

- Rainbow



- Halos



- Polar stratospheric clouds



- Noctilucent clouds



- Airglow



Other light phenomena

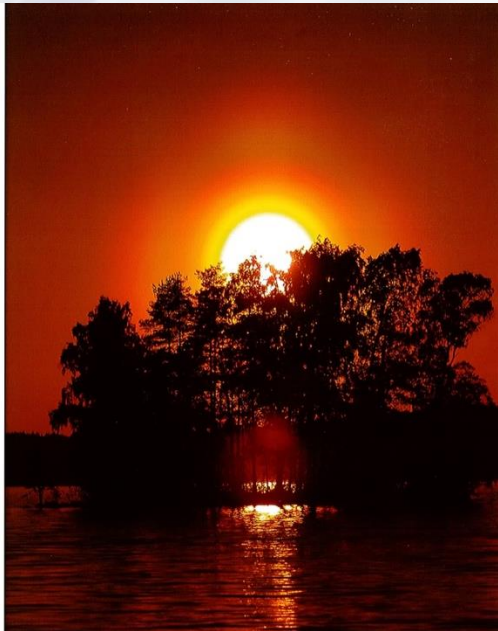
- Lightning



- Comets



- Rings



- Northern lights



Pohjoinen



Contact

- Jyrki Manninen
- Sodankylä Geophysical Observatory
Tähteläntie 62
99600 Sodankylä
- Tel: +358 294 480 824
- E-mail: Jyrki.Manninen@oulu.fi
- www.sgo.fi



You can ask what ever and when ever,
I promise to answer when ever and what ever.

Speculation...

- Why lakes and seas are blue?
- What is the difference between the rainbow and the halo?
- Why salt looks white although a single salt crystal is clear?
- Why the froth on beer is white although the beer itself has totally different colour?