



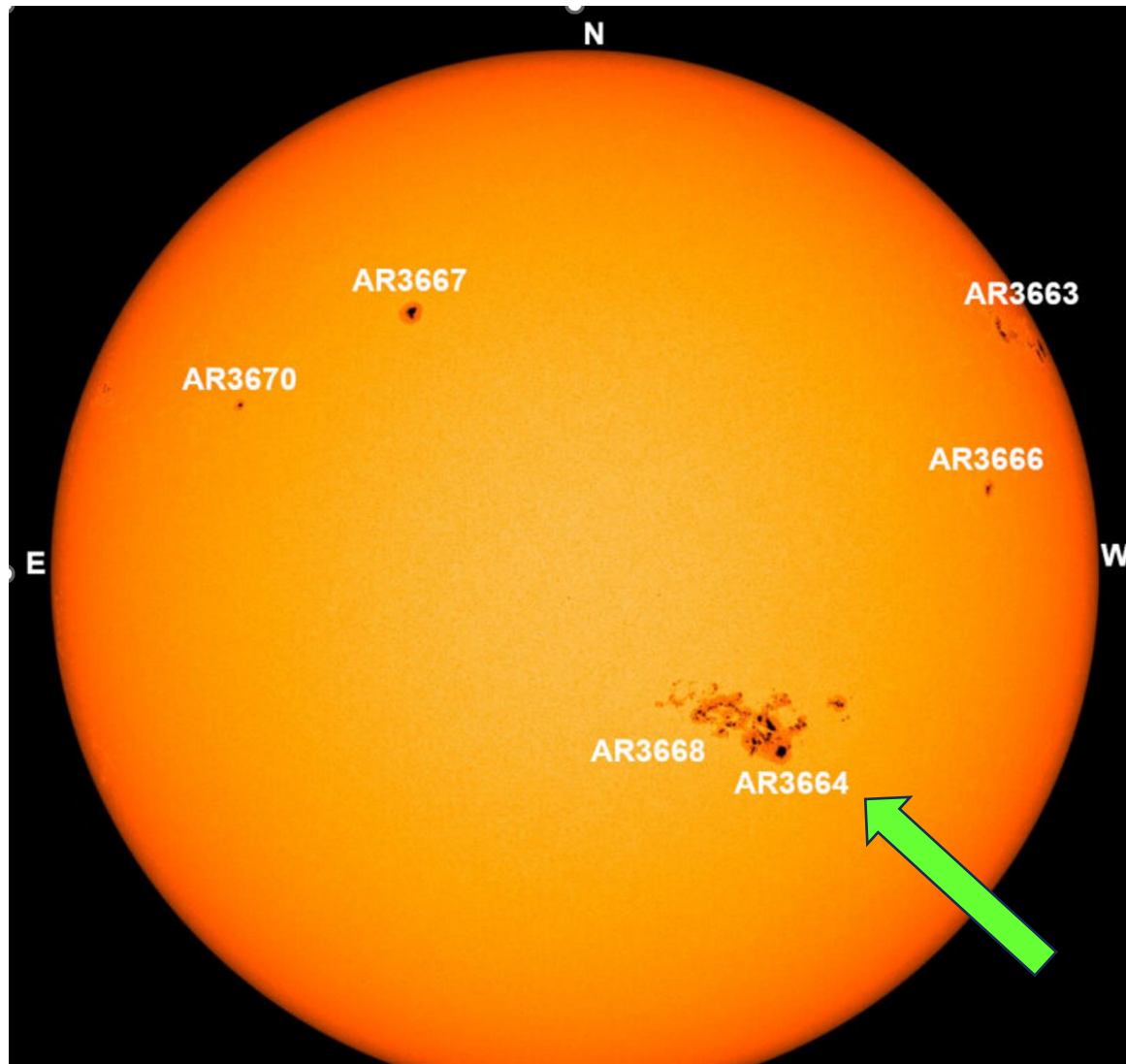
PARANYU PITHAYARUNGSARIT / GETTY IMAGES

Northern Lights – Why? When? Where?

July 6, 2024

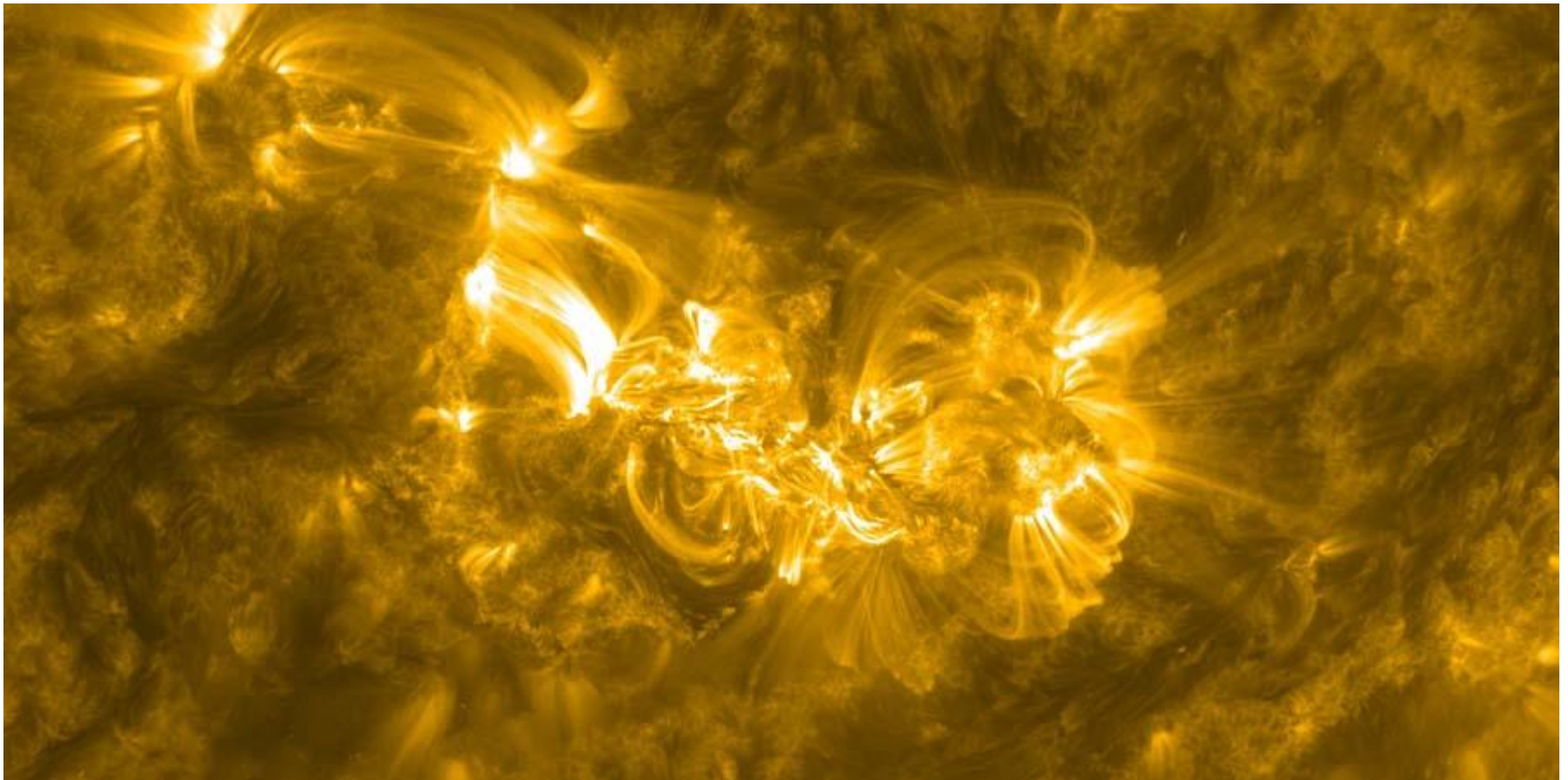
At a Star Not So Far Far Away....

- May 7: a large sunspot cluster rotated into view



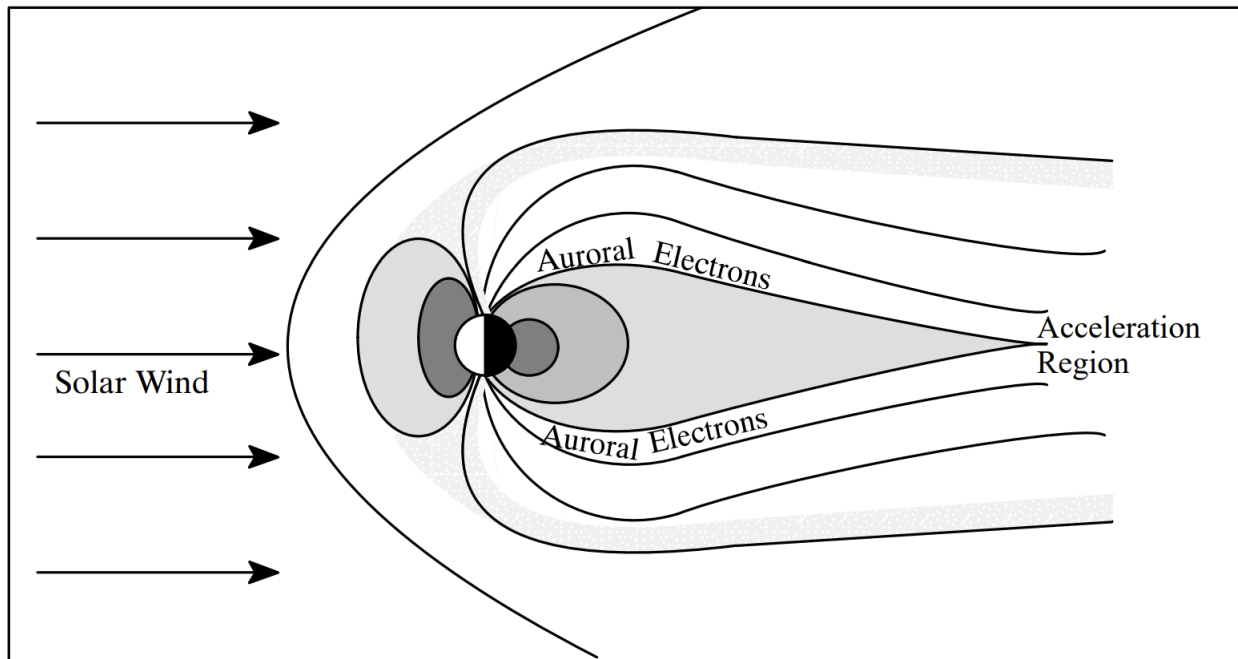
At a Star Not So Far Far Away....

- May 8: the sun released multiple coronal mass ejections (CMEs) in the direction of Earth

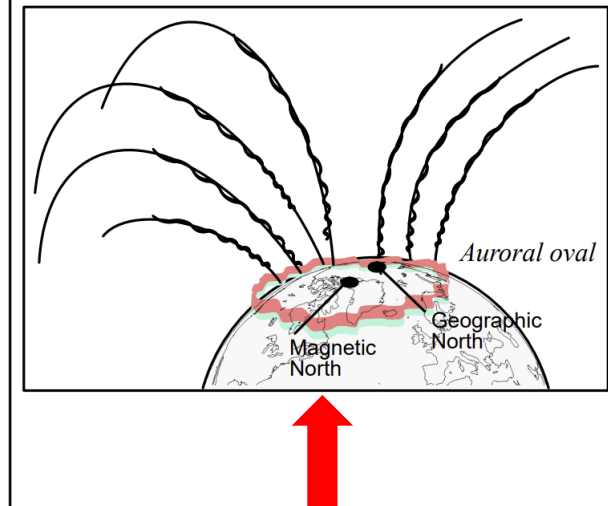


At a Star Not So Far Far Away....

- May 10: the first of the CMEs reached Earth causing an extreme geomagnetic storm



Space Environment Center (NOAA)



At a Star Not So Far Far Away....

- May 10-13: The northern lights shone brilliantly across nighttime skies around the world as far south as Florida, Mexico and Puerto Rico.



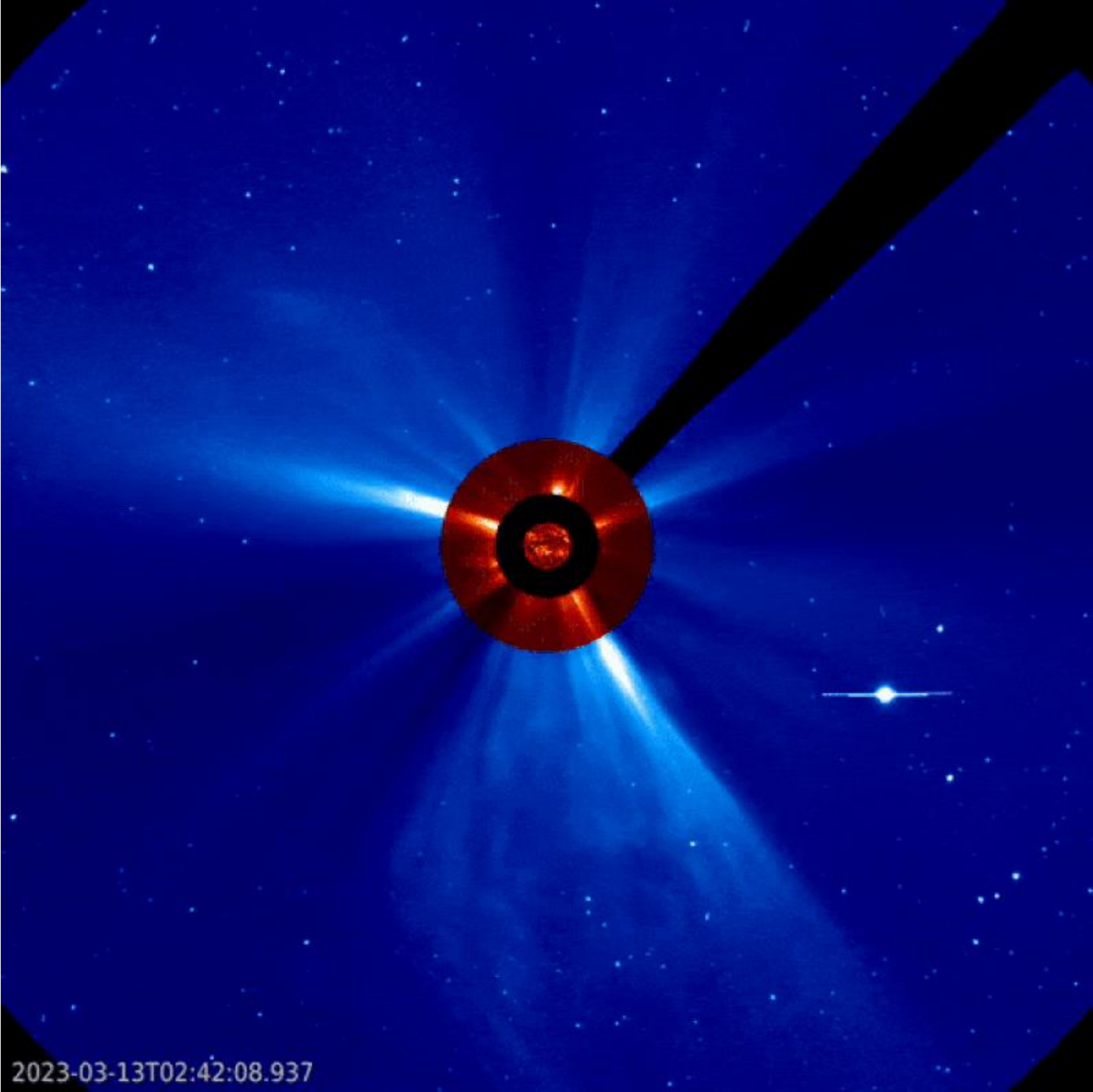
Our Sun is a Very Active Place

- Thermonuclear fusion – hydrogen (73%), helium (25%)
 - + Internal temperature: 27,000,000°F
 - + Surface temperature: 10,000°F
 - + Coronal temperature: 3,600,000°F
- Sunspots - cooler due to magnetic fields: 7,500°F
 - + 11 year cycle: 2024 is the peak year
 - + Same sunspot may rotate into view every ~27 days
- Solar flares - sun's magnetic fields explosively realign, driving energy into space
 - + Mostly emits light/x-rays: 8 minutes to reach earth
 - + Some high-energy particles: ~20 minutes to reach earth
 - + Temporary degradation of radio/communications

Our Sun is a Very Active Place

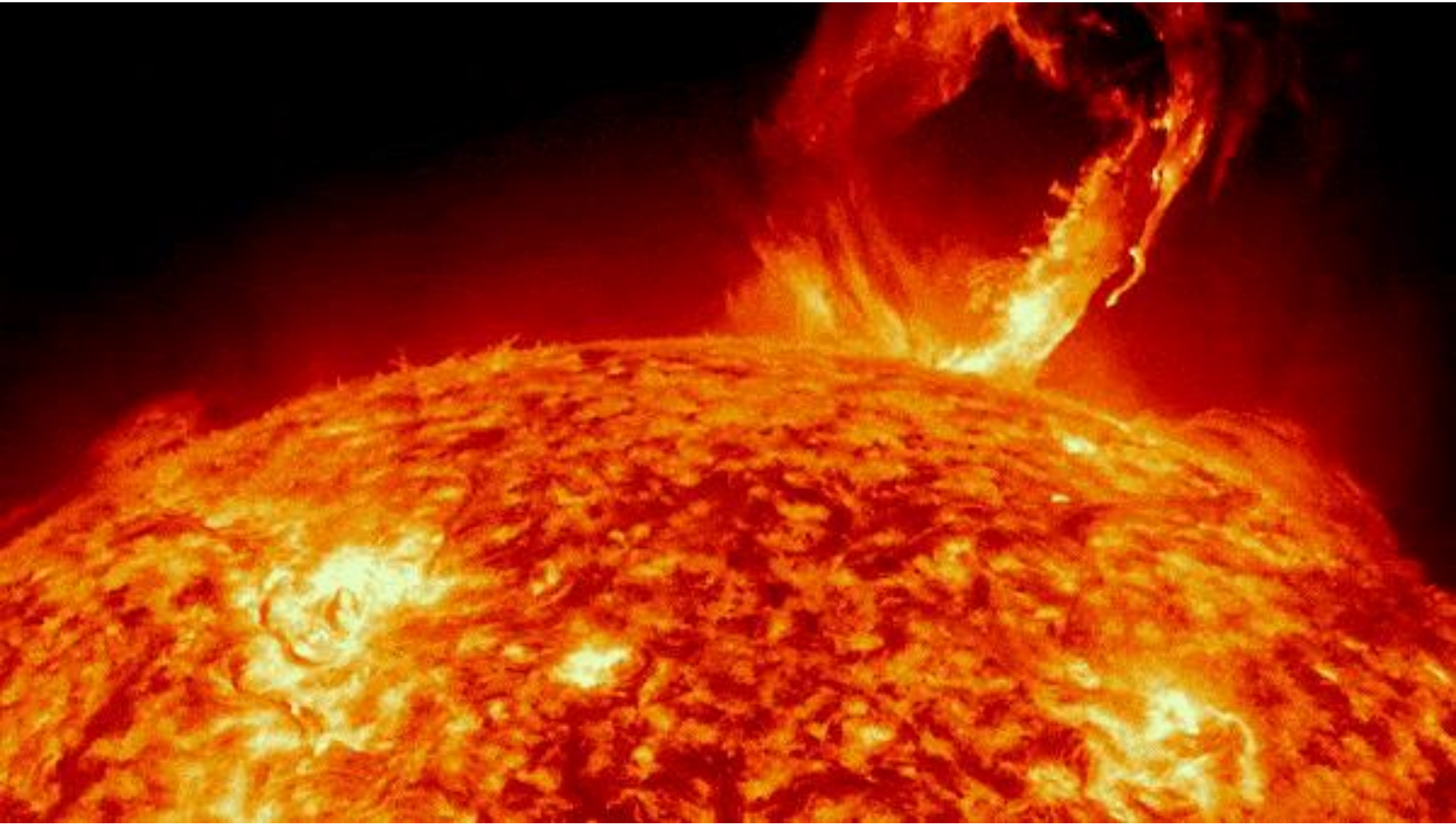
- Solar wind - ejecting charged particles from the corona
- Solar prominences – enormous loops of plasma suspended by sun's magnetic field after an explosion
- Coronal mass ejections (CME) - an immense cloud of magnetized matter (plasma) hurled into space in a particular direction, expanding as they travel
 - + Usually associated with sunspots, but can happen together with solar flares or solar prominences
 - + Matter travels > 1 million mph, 3 days to reach earth
 - + Distorts earth's magnetic field, creating currents driving particles to the poles, reacting with air, giving off light, wavy
 - + Magnetic field oscillations create electrical currents in utility grids, disrupt communications and GPS applications
 - + Impacts continue until the CME 'cloud' passes

CME: SOHO/NASA

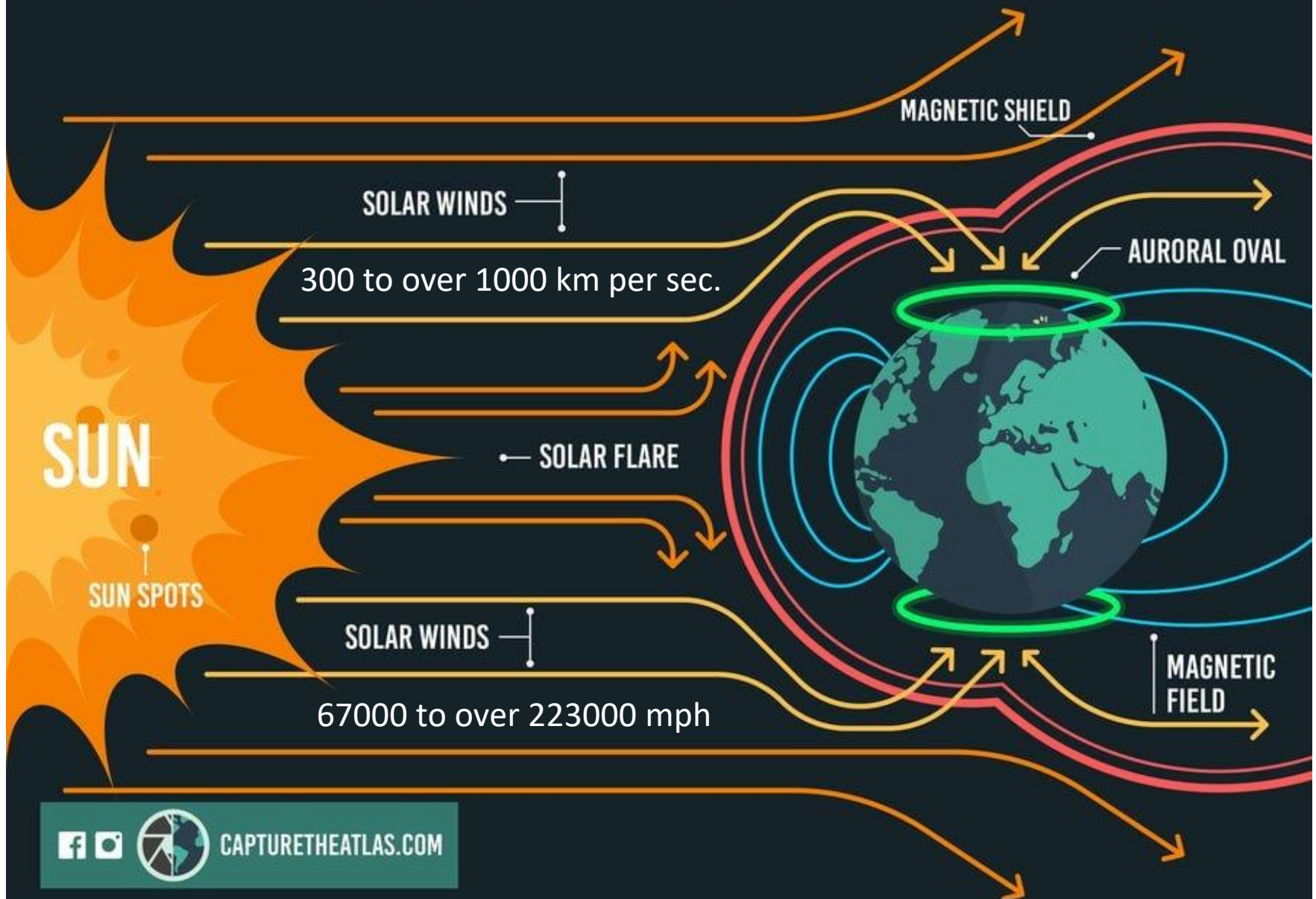


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Flares and CME



WHAT CAUSES THE NORTHERN LIGHTS?



CAPTURETHEATLAS.COM

Space Environment Center (NOAA)

The Cause of the Aurora

Excited oxygen
emits radiation

Red Light
(630 nm)

Green Light
(557.7 nm)

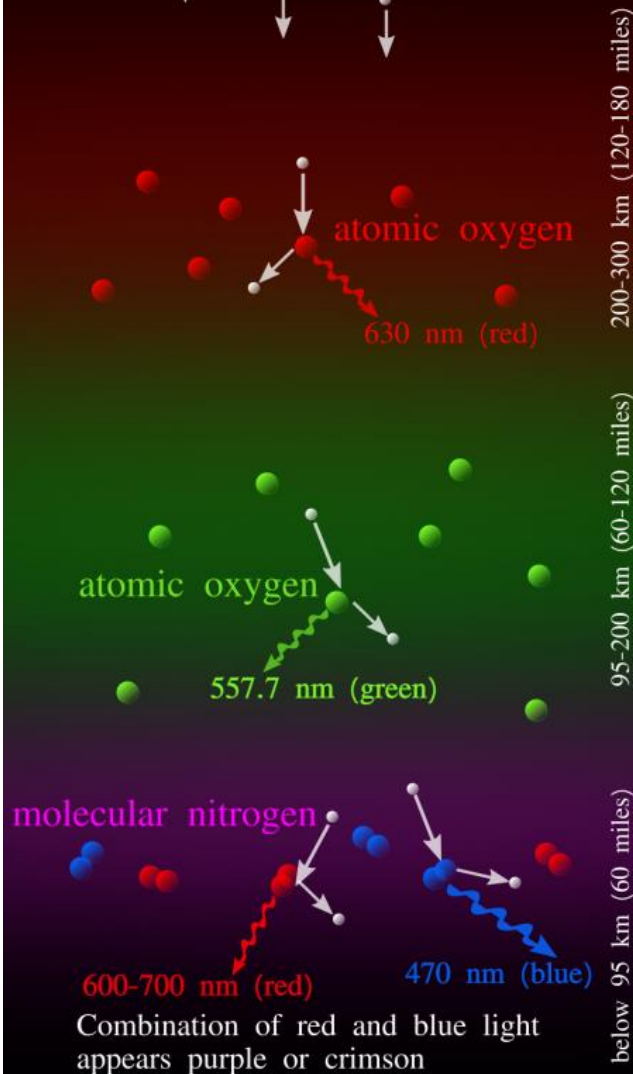
Excited nitrogen
emits radiation

Red Light
(600–700 nm)

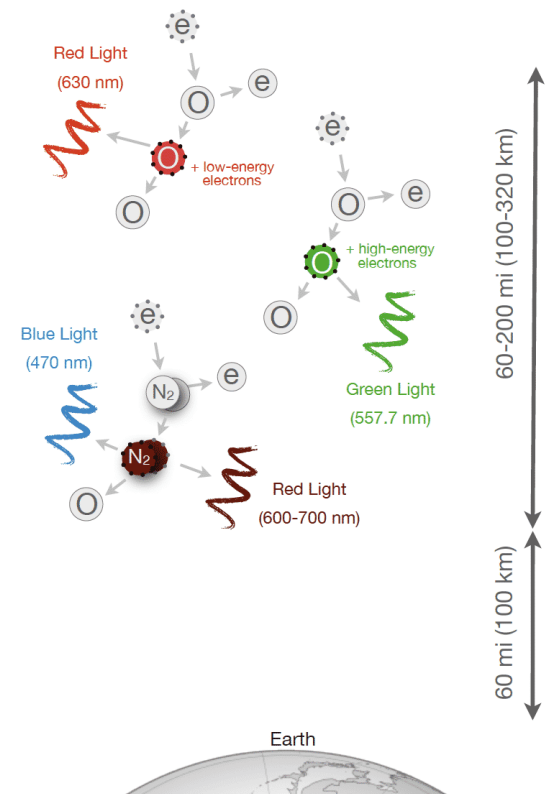
400 km

100 km

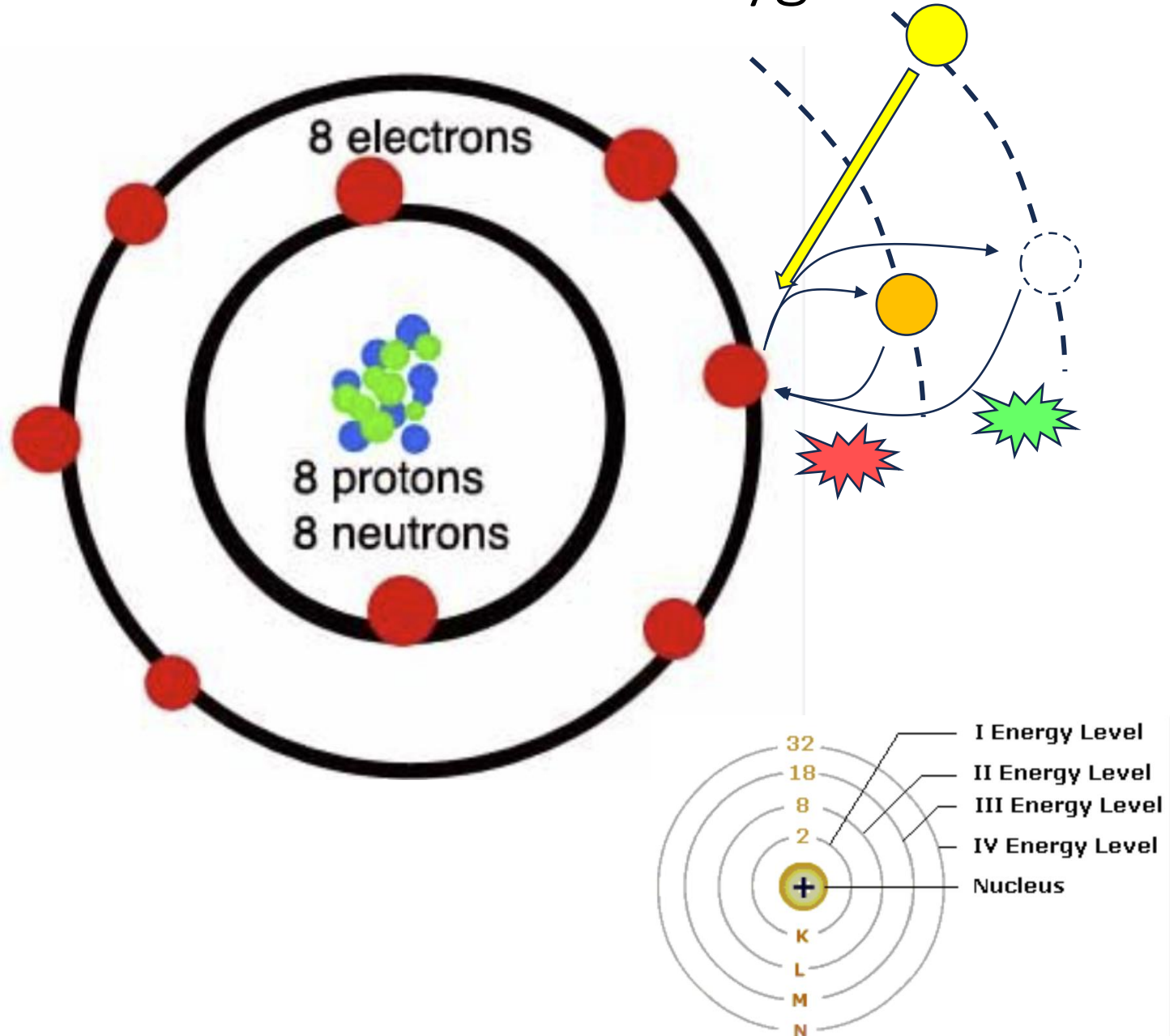
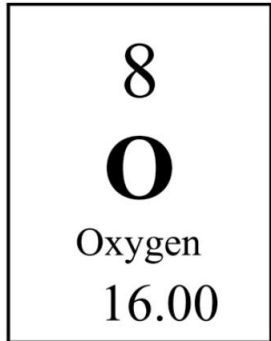
High energy electrons



What Causes the Colors of the Northern Lights?



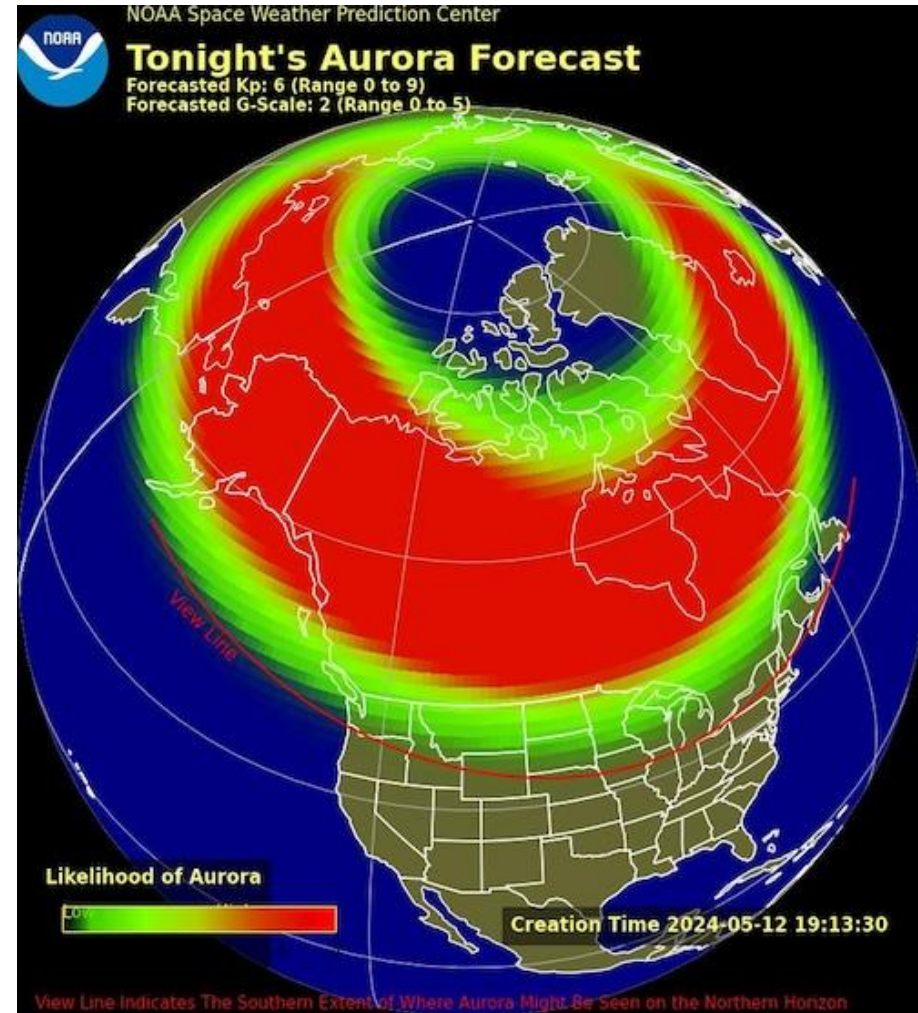
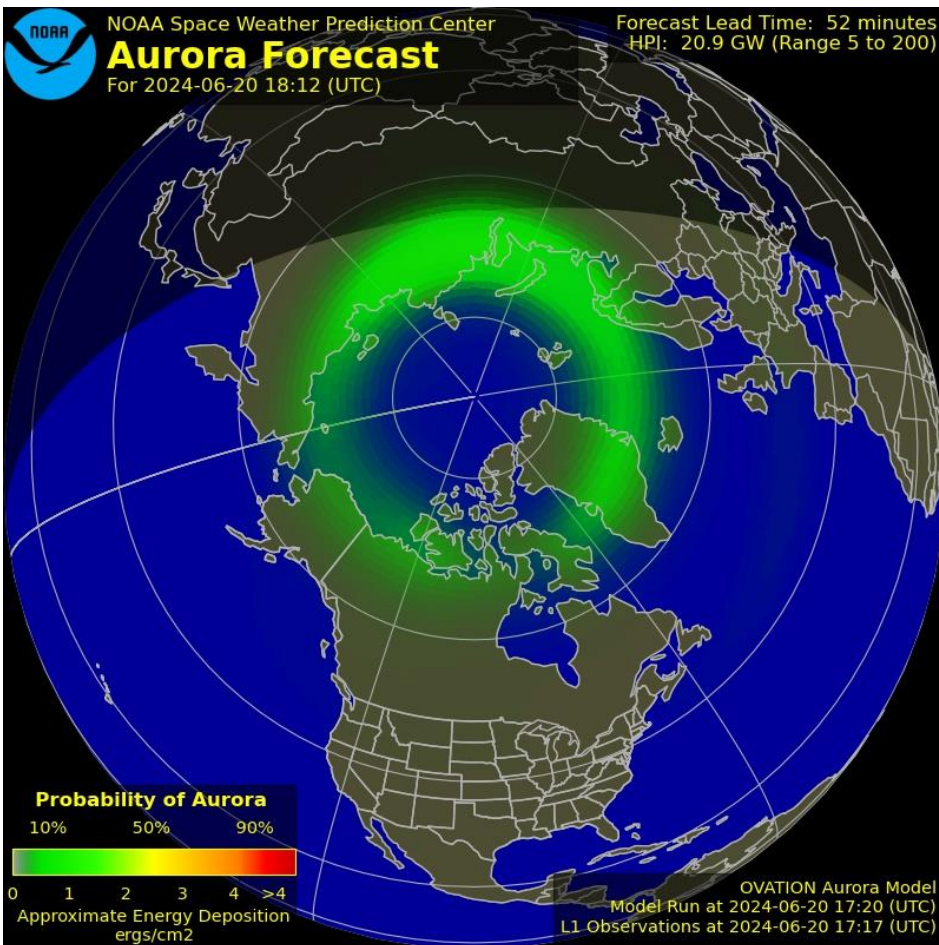
Bohr Atomic Model of Oxygen



Where / When Can They Be Seen?

- Normally seen north of 60° latitude
- But not visible in summer in high latitudes due to the midnight sun
 - + August-May are best times
- Seen in 'lower 48' during high solar activity
 - + Need dark skies without cloud cover
- Seen from orbit
 - + See video from Canadian Space Agency
- Other planets...

Auroral Oval



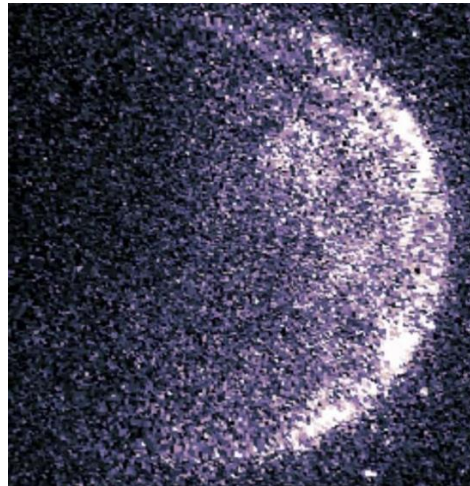
SPACE WEATHER PREDICTION CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

2015-08-15 - Photo taken by NASA astronaut Scott Kelly during his one-year mission on the ISS. (Credit: [NASA](#))



Are there Aurora Elsewhere in the Universe?

- Moon – no magnetic field, no atmosphere
- Venus – no magnetic field
- Mars – some, due to local magnetic fields, faint
- Jupiter – yes – very strong magnetic field, different atmosphere creates different colors (mostly UV)
- Saturn/Uranus/Neptune – yes – weaker UV
- Exoplanets – probably



Mars



Jupiter