Auroral Forms at Midlatitudes

Michigan Aurora Chasers 4rth Annual Workshop

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3/20/26

What is an Aurora

An Aurora - sometimes referred to as Polar Lights, is a natural light display in the Earths sky, predominantly seen in the high–latitude – The Arctic and Antarctic – regions.

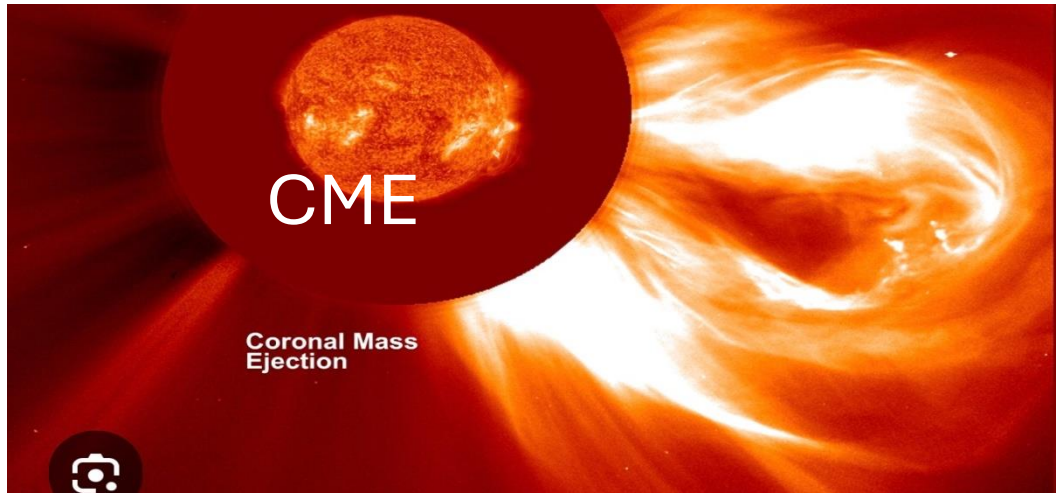
Auroras are the result of disturbances in the magnetosphere caused by the solar wind. These disturbances are sometimes strong enough to alter the route of the charged particles in both solar wind and magnetospheric plasma. These particles, mainly electrons and protons, precipitate into the upper atmosphere.

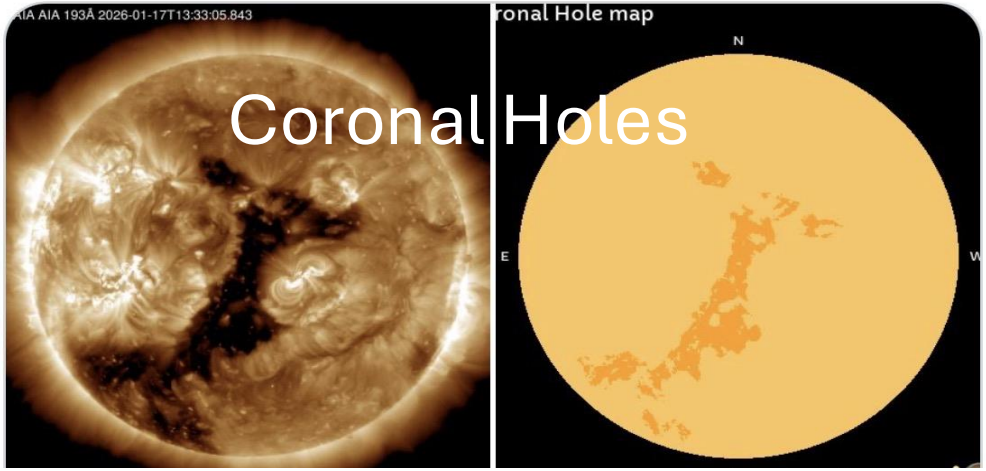
Aurora Borealis – Northern Lights

Aurora Australis – Southern Lights

OUR SUN & SOLAR STAR ACTIVITY

spaceweather.live/l/ch





We have CME impact!!! Now What?

FORMS OF MID-LATITUDE AURORA!!!

Diffuse Aurora vs. Discreet Aurora??

- Diffuse Aurora
  - It’s Faint/ Soft Glows/Foggy
  - Lacks detail/unstructured
  - May look like patches/bands
  - Cover large areas like in the recovery phase
  - Can be pulsating during recovery phase
  - Observed Equatorward
  - 80% of Total Aurora
- Discreet Aurora
  - Very Distinctive forms
  - Rays
  - Arcs
  - Curls
  - Curtains
  - Coronas
  - Beads

Diffuse Aurora


Discreet Aurora
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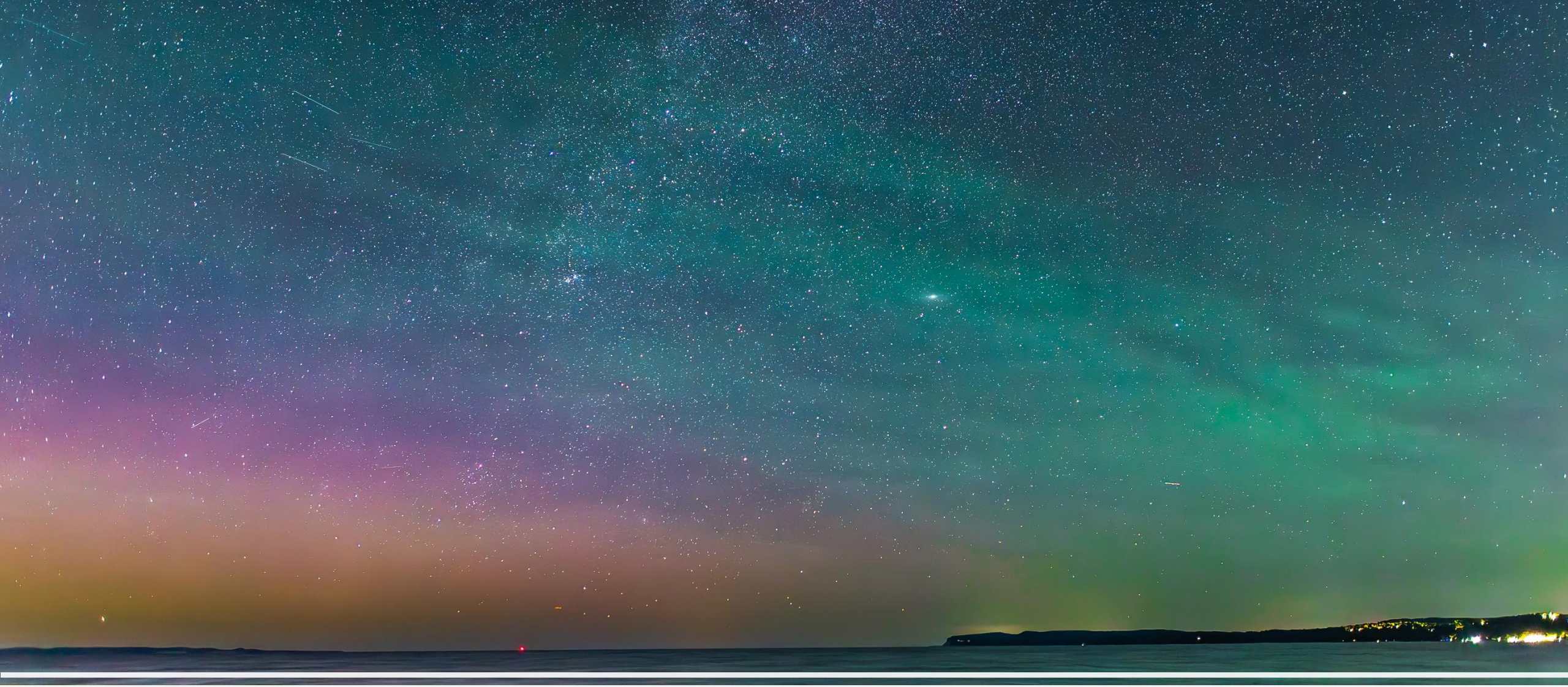

Diffuse Aurora & Air Glow


3 PHASES OF AURORA
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Growth Phase

- Faint arc which may grow in brightness and thickness
- Arc may swell up and split into 2 arcs
- Aurora is developing and charging up like a battery

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Expansion Phase

- The beautiful display begins!
- Most active phase (Discreet Aurora)
- Aurora takes on various forms of color like beads, curtains, rays, etc…

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Recovery Phase

- Substorm is subsiding
- More diffuse aurora
- May see patches and pulsating aurora during this phase

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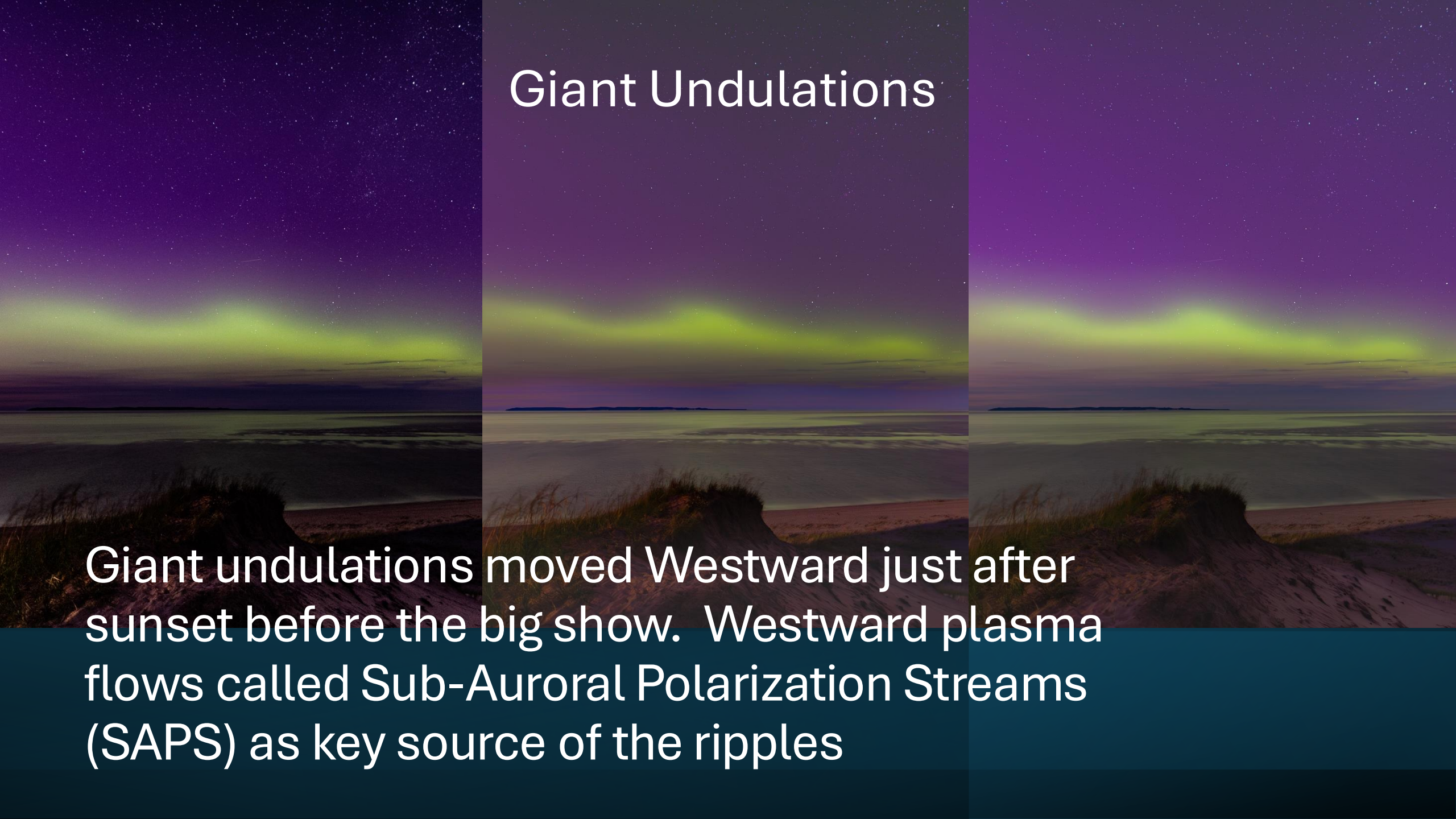
Auroral Arcs

Aurora Arcs – Double Arc! Stick Around!!!

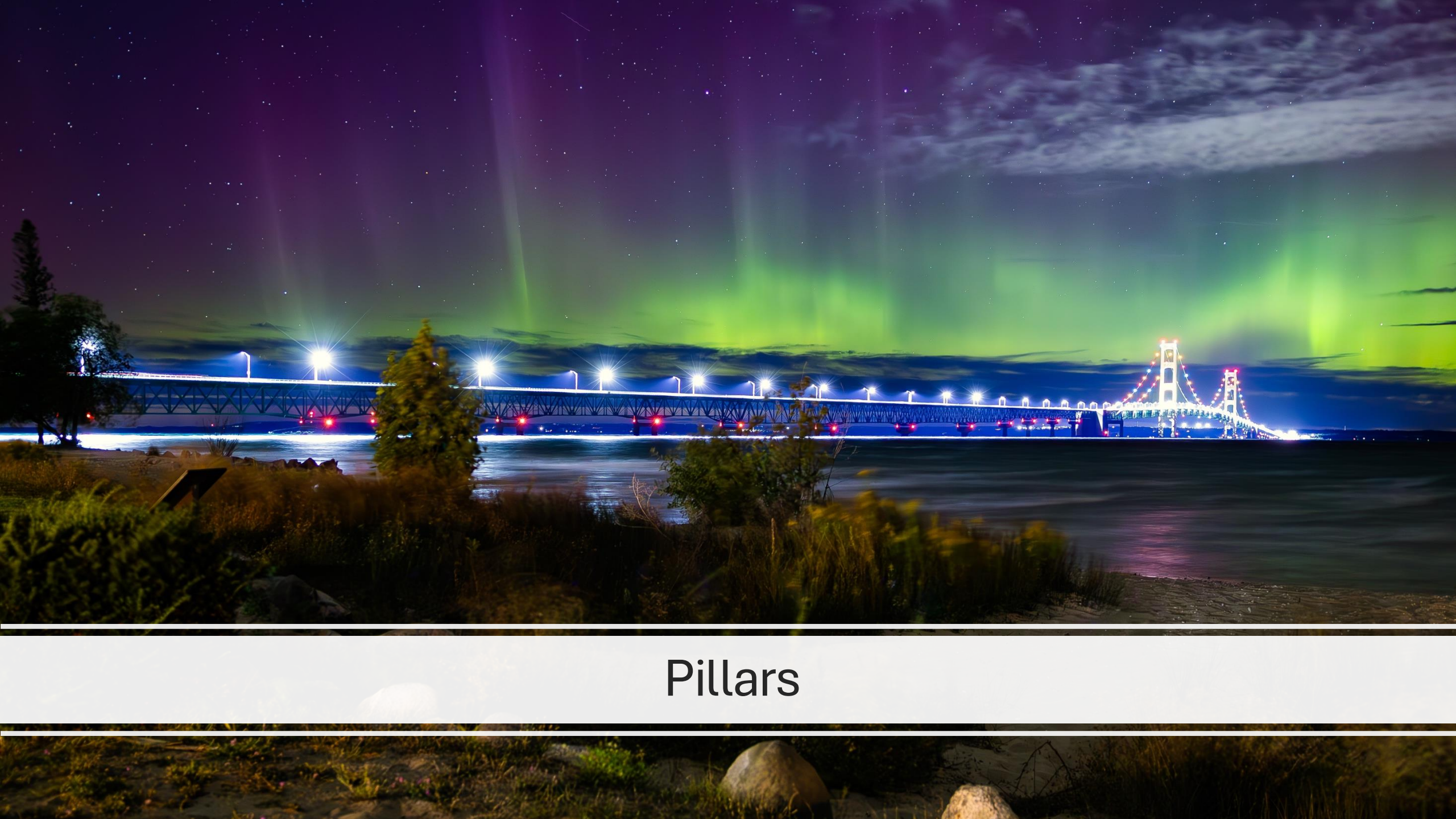
Giant Undulations



Giant undulations moved Westward just after sunset before the big show. Westward plasma flows called Sub-Auroral Polarization Streams (SAPS) as key source of the ripples

Auroral Beads

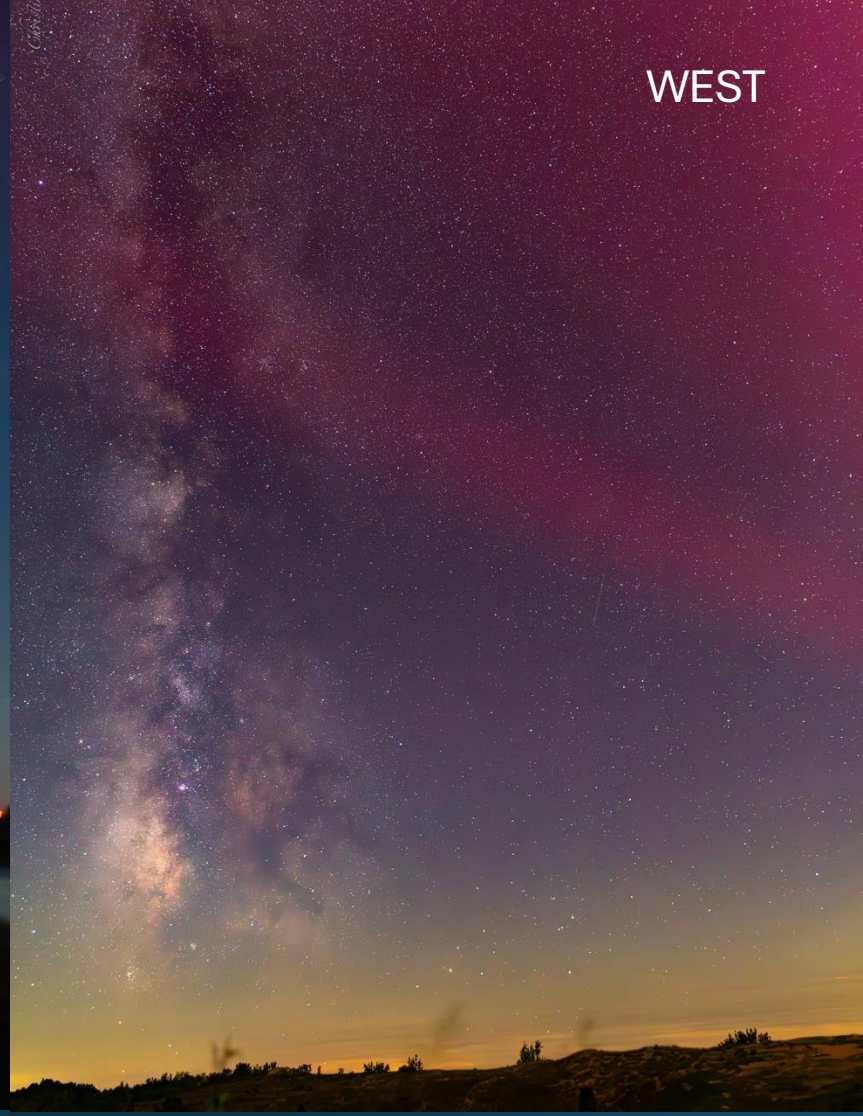
Usually see them at the beginning of a substorm before the show starts



Pillars

Rays & Curtains

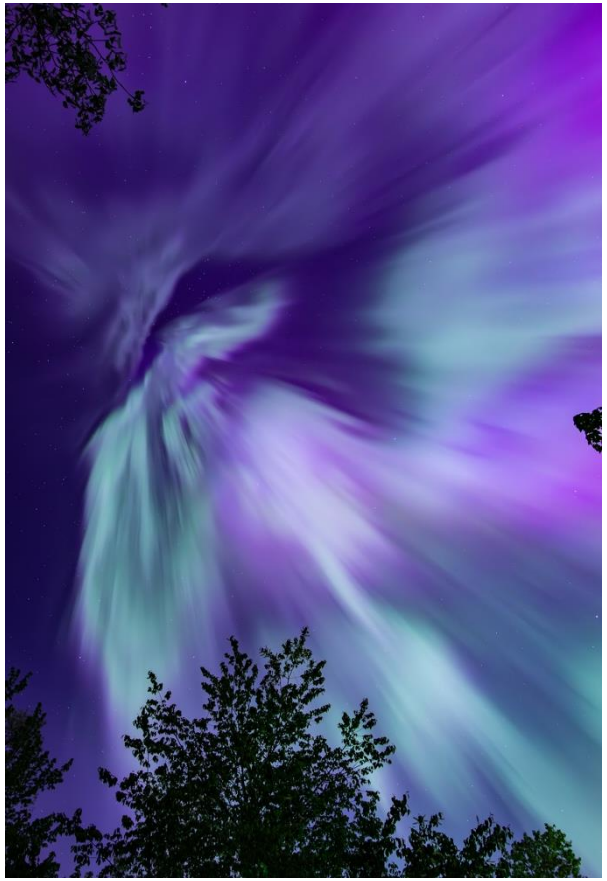
Rays & Curtains

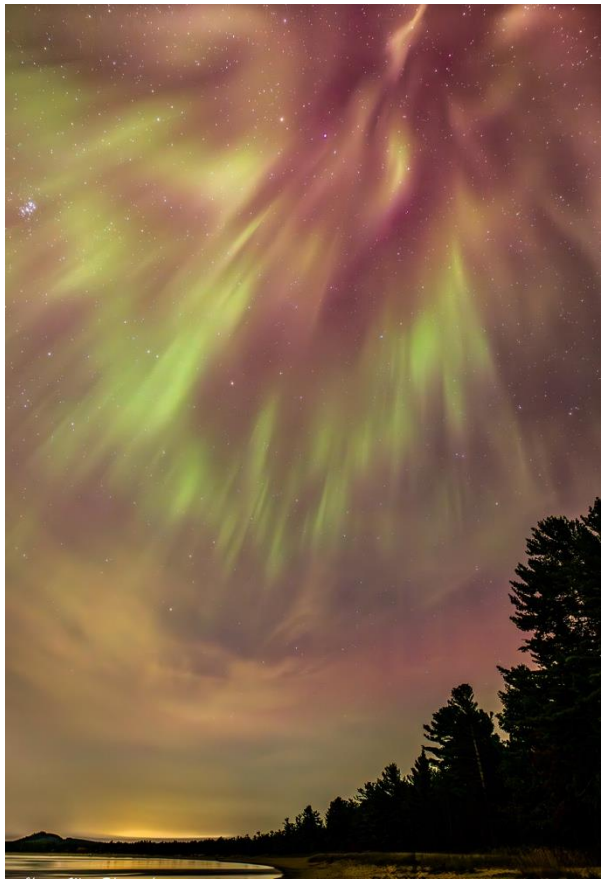


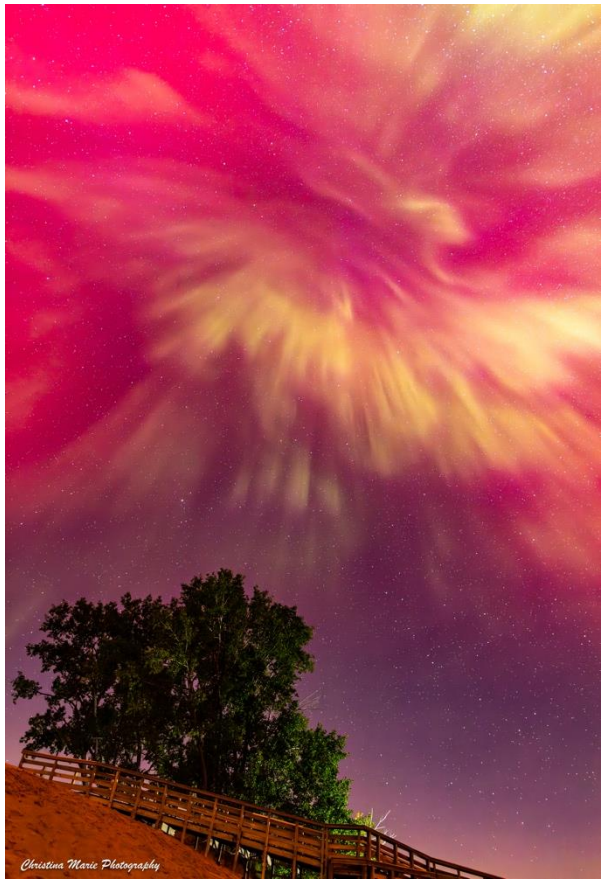
Stable Auroral Red (SAR) – Appears equatorward of the main aurora display and glows deep red – form same region of atmosphere as STEVE

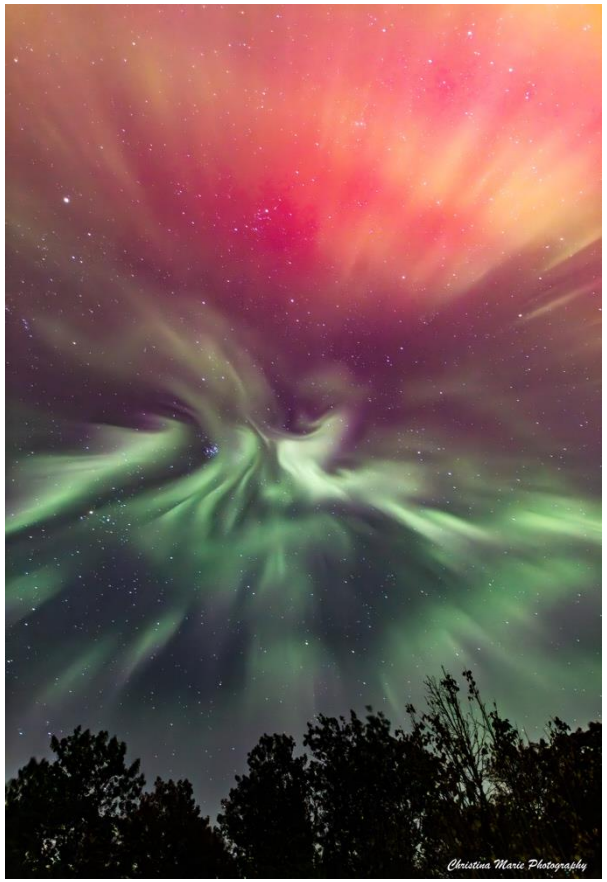
Coronal Aurora - “Wreath of Crown”

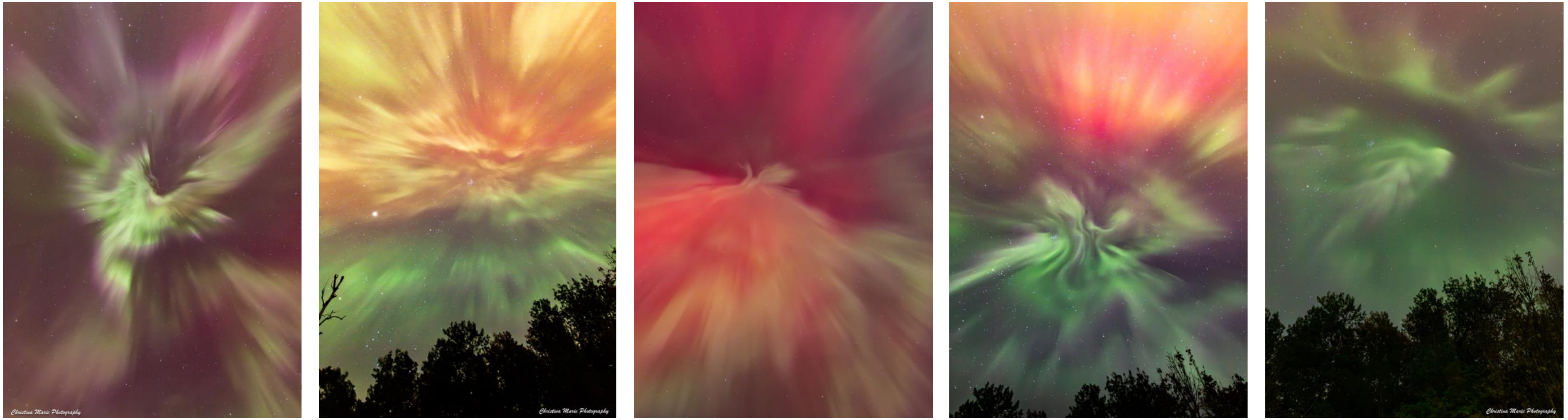
- It can be pulsating / flashing
- It may be both naked eye visible or camera only







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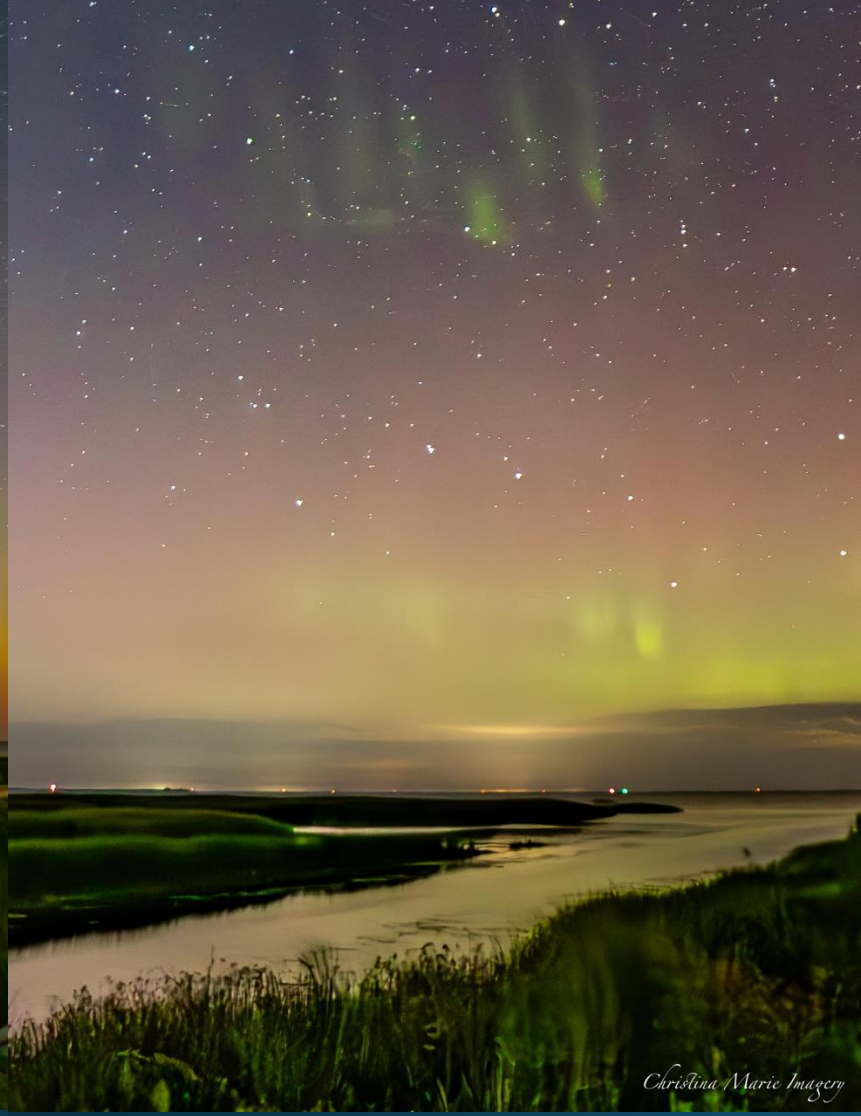
Coronas



Streaks

Streaks are the horizontal green patches below thee STEVE's pickets, and are perpendicular to the magnetic field direction

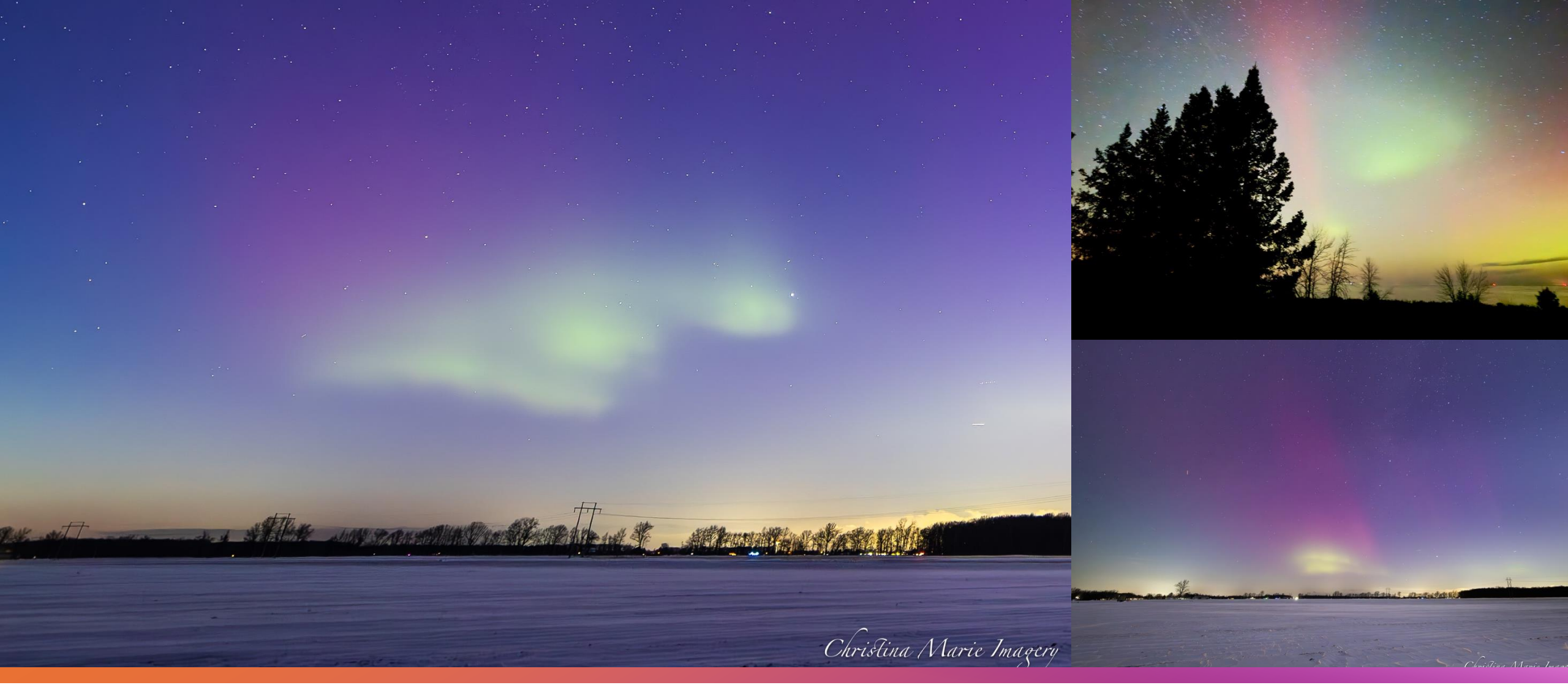
Isolated Proton Aurora (IPA) & Proton Aurora Arc

- Usually happens after dusk but can also happen just before sunrise
- It will always be detached from the main aurora
- Red and Green emissions are produced by excited oxygen; blue from nitrogen caught mostly by camera

Continuum Emission

- Are made up of all the different colors in the visible wavelength range, which combine together to appear off-white
- Characteristic of STEVE primarily occurring at the equatorward edge of the aurora oval
- Appear as thin or wide arcs or more rayed structures
- Can last seconds to hours

Photo credit: Patrick Grubba



RAGDA (Red Arc with Green Diffuse Aurora)

Curls – Seen more during stronger storms when you are more under the aurora oval – G4 here

Dunes (dune shelf)

- Type of Night Sky emission consisting of diffuse green light exhibiting a wave-like field of parallel fingerlike structures – dim to the eye
- Close to the equatorward edge of the auroral oval
- East – West direction and can drift for hours
- Rare – Most often between Oct – Jan

Sunlit Tops

- Nitrogen molecules seen in the higher altitudes and look blue when the sun hits them.
- Can be seen just after sunset or right before sunrise

Nitrogen Fringe

- Usually visible during strong geomagnetic storms
- Energetic electrons from solar storms reach deeper into the atmosphere, colliding with neutral or ionized molecular nitrogen
- Purple, blue, or pink edge to the main green auroral curtain creating a “fringing” effect on bottom of the main auroral display
- Happens closer to earth, at or below 100km (60 miles above the earth)

Red Aurora

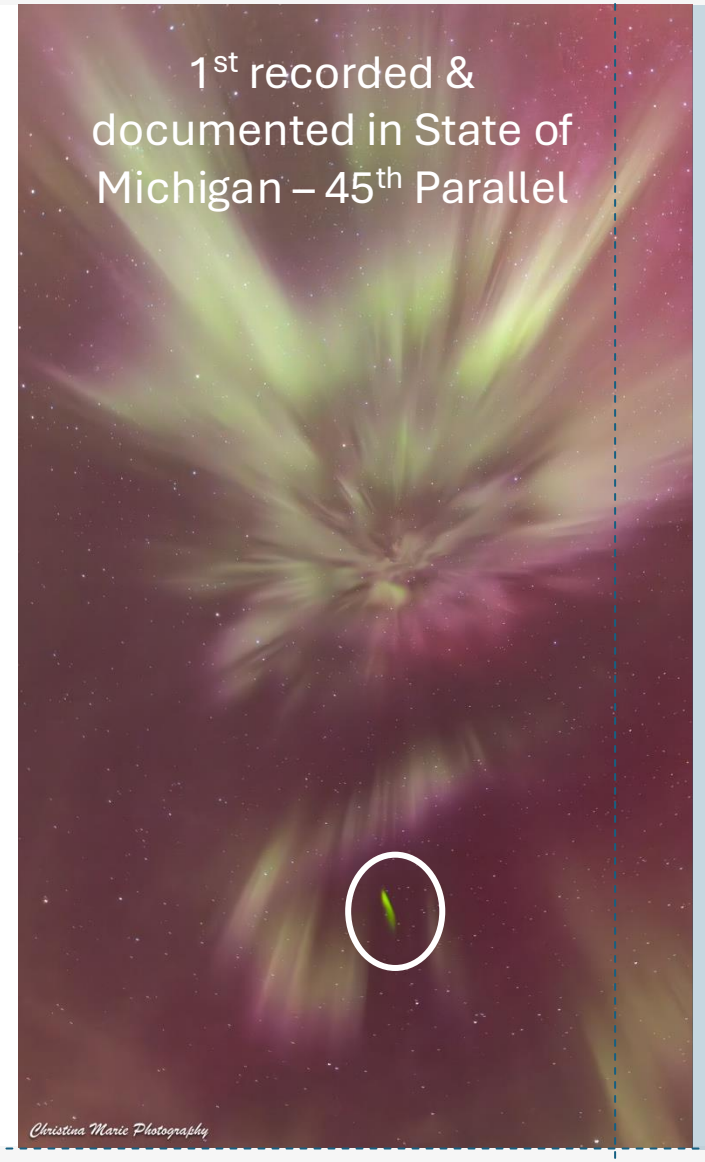
Rare – Oxygen atoms glow red happens > 120 miles above the earth’s upper atmoshphere

Pulsating Aurora

- Usually occurs during recovery phase and in-between substorms
- Sometimes you can see them with the naked eye if the storm is really strong. Camera can capture more colors and shapes overhead. I have caught several overhead coronas during this time
- Looks like watercolor paintings

Fragmented Aurora Emissions (FAE)

- Small green blobs similar to picket fence streaks
- Short-lived lasting seconds to a minute
- Occur at roughly 110-120 km in the lower E-region ionosphere
- Likely caused by local heating (thermal instabilities, driven by strong electric fields in the ionosphere.
- Often appear after substorm (recovery phase) during high-speed plasma flow events
- It can appear as a single FAE or in a wave-like
- Aurora – like emission



Single FAE Photo Credit: Christina Marie Imagery
Multiple FAE Photo Credit: The Aurora Guy – Vincent Ledvina

The Famous STEVE!!!

Strong Thermal Emission Velocity Enhancement

- Generally occur before Midnight during recovery phases of substorms
- Fast flowing river of hot plasma flowing east to west equatorward of the aurora
- Check in the Northwestern sky for Michiganders and Southeastern sky for Southern Hemisphere
- Bright Purplish ray at a steep angle apart from Aurora
- Typically 5-10 degrees to the its south
- Most commonly seen during equinoxes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STEVE
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STEVE
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Picket Fence

Rare sub-auroral phenomenon consisting of short, rapidly evolving green vertical rays that often accompany the mauve-colored atmospheric light band adjacent to or below STEVE

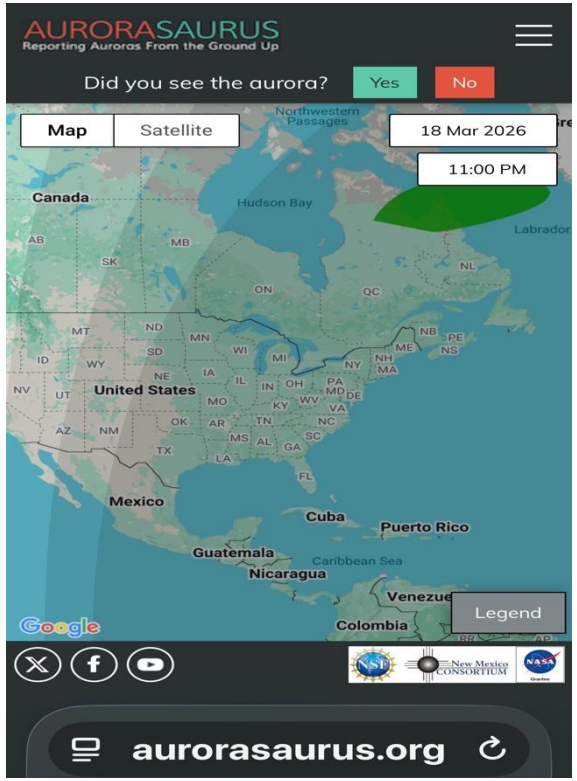
Photo Credit: Patrick Grubba

G3 AURORA

Citizen Science and You!

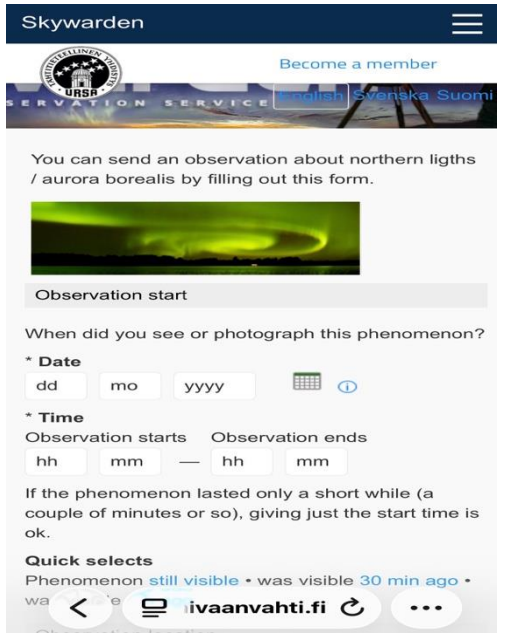
Aurorasaurus
Reporting from the Ground Up

- https://www.aurorasaurus.org



Skywarden Observation Service

- https://www.taivaanvahti.fi/observations/browse/pics/0/observation_id/desc/80/20

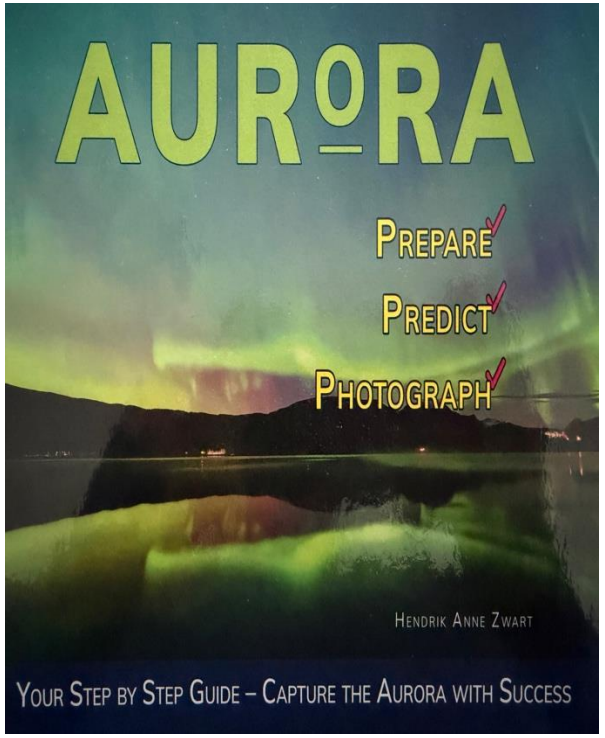


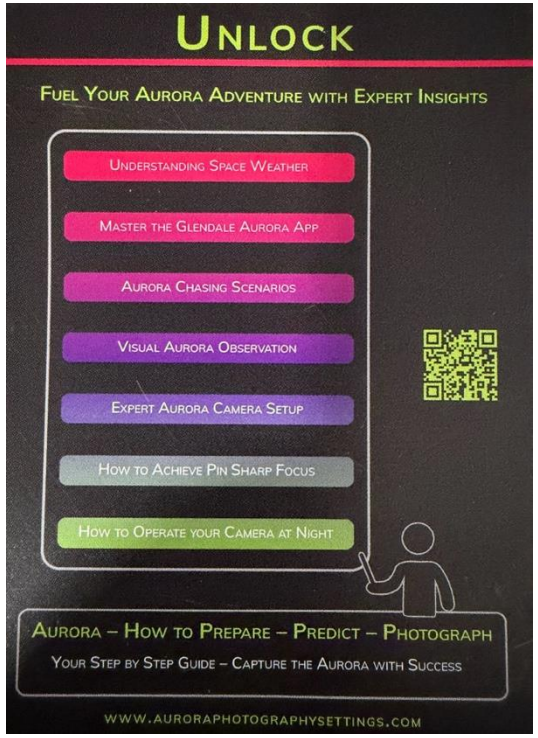
Citizen Science Reporting

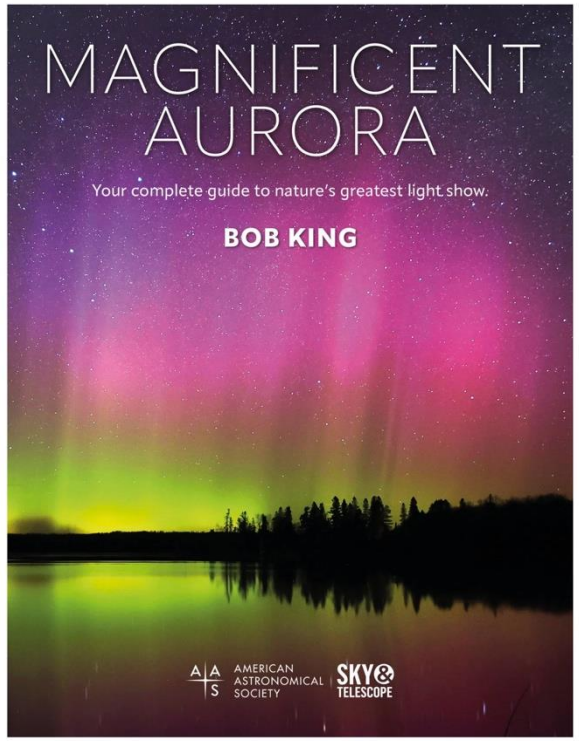
- Shoot in RAW images – Raw Data File will provide the most information if available
- Good exposure
- Location: GPS coordinates (10 m accuracy)
- Date & Time: Recorded in Universal Time (1s accuracy) , be sure to compensate for daylight savings time
- Camera Settings: Exposure time, aperture, ISO
- Camera Type and Lens information

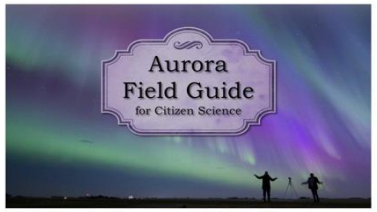
- Be sure to check out the ARCTICS Aurora Field Guide And Handbook for more information and examples of all kinds of aurora forms, tips, and education at your fingertips.
- https://kherli.github.io/Aurora-Field-Guide-And-Handbook/

References Used



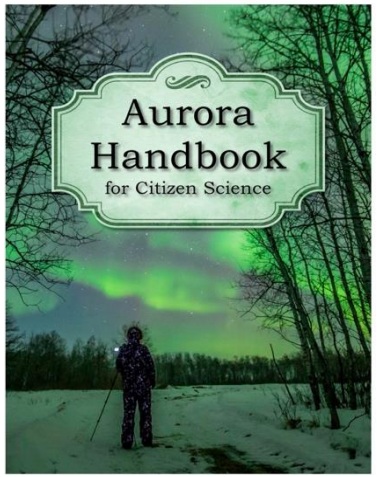






Click Here for the Aurora Field Guide

Aurora Handbook for Citizen Science



QUESTIONS???

ARCTIC AURORA