

Aurora Simulator

Classroom worksheet · Interactive simulation: <https://lkforge.com/tools/physics/aurora-simulator/>

Name: _____ Date: _____

Learning objectives

- Explain how the solar wind and Earth's magnetic field produce the aurora.
- Distinguish particles that reach the atmosphere (the loss cone) from particles trapped in the radiation belts.
- Relate the aurora's colours to the gases and heights that emit them.

Variables to change

- Solar wind strength
- Magnetic field strength

Procedure

1. Start at Moderate solar wind and field strength $\times 1.0$, and note where on Earth the aurora appears.
2. Record the "Reaching the atmosphere" and "Trapped in radiation belts" readouts.
3. Raise the solar wind to Storm and record both readouts again.
4. Return to Moderate, raise the field strength to $\times 3.0$, and compare the spirals and the spiral-radius readout.

Observations

Record where the aurora forms, how the two particle counts change with the solar wind, and how the spiral size changes with the field strength.

Questions

1. Where does the aurora appear, and why not exactly at the poles?
2. What happened to the rate of particles reaching the atmosphere when the solar wind increased?
3. Why do some particles bounce between the hemispheres instead of reaching the atmosphere?
4. Using $r = mv/(qB)$, by what factor does tripling the field change the spiral radius?
5. Why is most aurora green, and what produces red and purple?

Answer key (instructors)

- **1.** On a ring at about 60–65° latitude around each magnetic pole — the auroral oval — because the field lines that reach far into space, where particles are captured, meet the Earth there.
- **2.** It rose — more incoming particles means more reach the atmosphere, so the aurora brightens, as in a geomagnetic storm.
- **3.** Their pitch angle is too steep: as the field strengthens toward a pole, the magnetic mirror reflects them before they reach the air, trapping them in the radiation belts. Only particles in the loss cone get through.
- **4.** It becomes one third (0.33x) — the radius is inversely proportional to B.
- **5.** Green is oxygen emitting at 557.7 nm around 100–250 km; red is oxygen at 630 nm above about 250 km; purple and blue come from nitrogen lower down.

Charged particles from the solar wind are captured into Earth's magnetic field and spiral along the field lines. Those moving nearly along the field (inside the loss cone) reach the upper atmosphere on the auroral ovals, where collisions make oxygen and nitrogen glow; the rest are reflected by the magnetic mirror and stay trapped in the Van Allen belts.