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Fires in the Night Sky: All About Aurorae

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All About Aurorae

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On a frigid winter evening in Iceland you might be fortunate enough to witness curtains of brilliantly-colored lights gently rippling in a star-studded night sky. This phenomenon, commonly referred to as the northern lights or aurora borealis, has existed since the creation of our planet.

A variety of different cultures have long described aurorae with a certain magical mysticism. The Finnish word for the northern lights is revontulet, directly translating to "fox fires," referencing a fable in which a magical fox swept its tail across the snow, flicking flakes up into the night sky. Other Finnish myths describe aurorae as the spray from whale spouts. Algonquin Indian folklore of southeastern Canada attributes the northern lights to Nanabozho, the Creator of the Earth who continues to light great fires in the heavens, reminding the world of his everlasting love. Much farther to the south, the Maori people of New Zealand described the southern lights, or aurora australis, as the campfires of their ancestors.

But what causes these captivating night lights? Interestingly, the story of aurorae begins at the sun, far beyond our planet's atmosphere. The sun constantly produces the solar wind, a current of charged particles that flows throughout space. Fluctuating temperatures on the sun's surface cause solar storms that alter the strength of solar wind and lead to bursts of plasma called coronal mass ejections. Aurorae occur when the Earth happens to intersect the path of the solar wind as it travels through space.

The sun's solar wind is only part of the story; aurorae also depend on a unique characteristic of our planet. Just like a bar magnet, the Earth has a positive and a negative end. The Earth's magnetic field flows out of one pole, looping out in all directions, and comes back in at the other pole. This creates a large, squashed, beach-ball shape known as the magnetosphere. The magnetosphere is integral

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to maintaining a hospitable environment for life on Earth because it blocks incoming radioactive material carried by the solar wind. During a coronal mass ejection, the magnetosphere blocks most of the solar wind from entering our atmosphere. The force of the solar wind pushes the magnetosphere into a teardrop shape, where the side facing away from the sun develops a long tail of magnetic charge that extends even beyond our moon's orbit! In this way, the magnetosphere acts as a sort of shield, protecting the planet from the harmful radiation of solar storms. However, some ions from the solar wind manage to pass through the magnetosphere, following the Earth's magnetic field lines down into the planet's upper atmosphere at the poles. There the ions collide with atoms in our atmosphere, releasing the brilliant lights seen in aurorae.

The color given off by such a collision can be explained by variations in altitude and colliding elements. Atoms are comprised of a central nucleus around which a diffuse cloud of negatively-charged electrons orbit. When the charged particles from the sun strike atoms

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in the atmosphere, the atoms' electrons are excited to higher energy levels, moving them away from the nucleus. When the electrons fall back down to lower energy levels, they release energy in the form of photons and give off light. The radiant colors of aurorae depend on both the identity of the atom and the altitude at which the collision takes place. Ions colliding with oxygen atoms at higher altitudes give off red light whereas lower altitude collisions yield green and yellow hues. Nitrogen atom collisions appear red or blue. Hydrogen and helium atoms can produce purple, though this color falls within a part of the electromagnetic spectrum that our eyes can't detect.

Though aurorae generally appear as rippling sheets at the northern and southern poles, they also form spirals and arcs oriented along the Earth's magnetic field and occasionally appear at lower latitudes. Midlatitude aurorae may be seen when magnetic storms on the sun increase the activity of the solar winds and coronal mass ejections. Such magnetic storms typically occur near the spring and autumnal equinoxes and have generated aurorae seen as close to the equator as Mexico!

Furthermore, aurorae are generated through a similar mechanism to the neon lights that decorate the building fronts of any typical downtown street. Neon lights are made up of glass tubes filled with gases like helium, neon, or argon. Electricity is run down the length of the tube, colliding with the gas atoms and releasing colored photons of light. The next time a bright neon sign catches your eye, recall the dazzling natural displays of the aurora borealis and the aurora australis. • • •