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The Solar System's Passage through the Radcliffe Wave during the Middle Miocene

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As the Earth and the other planets orbit around the Sun, the Solar System itself revolves around the center of the Milky Way, our Galaxy. The Milky Was is far from being a static and homogeneous environment. On large scales, the stars, the gas, and the dust are organized into a rotating spiral structure that extend from the center into the galactic disk. On smaller scales, the environment between the stars, also known as the interstellar medium (ISM), is continuously shaped by different events and mechanism, like supernovae explosions, stellar winds, Galactic shear, magnetic fields, etc.

The Solar System, located at about 27’000 light-years from the center of the Milky Way, completes a full orbit around the Galactic center in about 225 million years (Myr). The constantly evolving environment, combined with the Sun’s peculiar velocity relative to the average velocity of the surrounding gas and stars, causes the Solar System to “sail” various Galactic environments with different gas densities.

Encounters with dense gas regions, such as gas clouds or supernova shock fronts, can compress the heliosphere, exposing parts of the Solar System to the ISM. These encounters also increase the influx of interstellar dust into the Solar System and Earth's atmosphere. A greater influx of dust would result into the decrease of the amount of sunlight reaching Earth and, by bringing radioactive elements from the supernovae, might also cause radionuclides anomalies in geological

records.

Recently, by the means of new astronomical data provided by the *Gaia* mission, the 3D structure of the environment surrounding the Sun has been unveiled. This has led to the identification of previously unknown Galactic structures, such as the Radcliffe Wave. This raises the question of whether the Sun has encountered any of these structures.

In our work, we study the passage of the Solar System through the Radcliffe Wave gas structure over the past 30 Myr. We find that the Solar System's trajectory intersected the Radcliffe Wave in the Orion star forming region. We have constrained the timing of this event to between 18.2 and 11.5 Myr ago, with the closest approach occurring between 14.8 and 12.4 Myr ago.

Notably, this period is synchronous with the Middle Miocene Climate Transition on Earth, providing an interdisciplinary link with paleoclimatology. We also estimate the potential impact of the crossing of the Radcliffe Wave on climate on Earth and suggest possible future developments for this work. As the crossing could also lead to anomalies in radionuclide abundances, we highlight its importance for the field of geology and nuclear astrophysics.