# Collaboration makes crystal-clear study of radiation reaction

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Two members of the NA63 collaboration adjust part of the set-up used by the team to measure the phenomenon of radiation reaction. Credit: NA63 collaboration

Place a charged particle in an electromagnetic field and the particle will accelerate and give off radiation. Typically, the emitted radiation has little effect on the particle's motion. However, if the acceleration is extremely large, as is the case for high-energy electrons or positrons in strong electromagnetic fields, the emitted radiation will drastically slow down the particle. The effect, known as radiation reaction, has been recognized since the beginning of the twentieth century, and is relevant in several branches of physics, from accelerator physics to astrophysics. But until now it has been difficult to pin down the maths that best describes the phenomenon. In a paper recently published in *Physical Review D*, the NA63 collaboration reports a high-precision study of the phenomenon that shows that an equation proposed long ago does the job remarkably well.

The NA63 team has previously investigated radiation reaction by firing a beam of high-energy positrons from the Super Proton Synchrotron at a silicon crystal. The phenomenon has also been studied by colliding a high-intensity laser beam with a high-energy electron beam. However, these two types of study were conducted in a regime in which quantum effects were dominant, and the laser-based experiments also used relatively small data samples with large data fluctuations, all of which prevented a high-precision study of the effect.

Enter the latest NA63 study. By directing a beam of high-energy charged particles (electrons or positrons) from the Super Proton Synchrotron at several (silicon or diamond) crystals of different thickness, one crystal at a time and with different angles at which the beam strikes the crystal, the NA63 team succeeded in studying with high precision the radiation reaction for the charged particles in the crystal's strong electromagnetic field. In all cases, the researchers measured the energy spectrum of the photons emitted by the charged particles, that is, they measured how the number of photons emitted by the charged particles varied with the photon energy.

They found that all of the measured energy spectra are in remarkable agreement with predictions based on the Landau–Lifshitz equation describing the dynamics of charged particles in a strong electromagnetic field if these predictions also include small changes from quantum effects.

"This classical equation was proposed in the 1950s to account for the effect of radiation reaction," said NA63 spokesperson Ulrik Uggerhøj. "Our new study has investigated for the first time the experimental regime in which the effect is dominant, and it showed that the equation does seem to describe this regime well."

**More information:** C. F. Nielsen et al. Radiation reaction near the classical limit in aligned crystals, *Physical Review D* (2020). DOI: 10.1103/PhysRevD.102.052004

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