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Neutral Bremsstrahlung in xenon unveiled

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Neutral bremsstrahlung emission in noble gases has been neglected in favor of excimer-based VUV emission. This alternative mechanism of secondary scintillation production was only recently unveiled in argon. We have found strong evidence of neutral bremsstrahlung emission in xenon, obtained using both the NEXT-White TPC, at present the largest optical Xe-TPC in operation, and a dedicated setup based on a Gas Proportional Scintillation Counter. The secondary scintillation yield was measured over 5 order of magnitude for a wide range of reduced electric fields. A non-negligible light production signal was detected even for low electric fields, under which drifting electrons have not sufficient kinetic energy to excite Xe atoms. Comparison with first-principle calculations allows us to assign this effect to neutral bremsstrahlung, which is intrinsically broadband and, as confirmed by our measurements, immune to quenching, unlike excimer-based electroluminescence emission.

For photon wavelengths below 1000 nm, the neutral bremsstrahlung yield increases from about $10^{-2}\ photon/(cm\, bar\, e^-)$ to above $3{\times}10^{-1}\ photon/(cm\, bar\, e^-)$ for reduced electric fields of about 50 $V/(cm\, bar)$ and 500 $V/(cm\, bar)$, respectively. At higher electric fields, above $1.5\ kV/(cm\, bar)$, the neutral bremsstrahlung intensity, around $1\ photon/(cm\, bar\, e^-)$, is about two orders of magnitude lower than conventional secondary scintillation.

Despite being fainter than its excimeric counterpart, neutral bremsstrahlung (originated in the 'buffer'and 'veto'regions) can interfere with the ability to measure low primary-scintillation signals in gaseous or liquid Xe TPCs. This new source of light emission opens a viable path towards the development of single-phase liquid Xe TPCs based on secondary scintillation amplification for neutrino and dark matter physics, avoiding the very high electric fields required by conventional electroluminescence.

Primary author: Dr HENRIQUES, Carlos (LIBPhys-Coimbra)

Presenters: Dr HENRIQUES, Carlos (LIBPhys-Coimbra); ON BEHALF OF THE NEXT COLLABORATION

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