Neutral Bremsstrahlung in xenon unveiled

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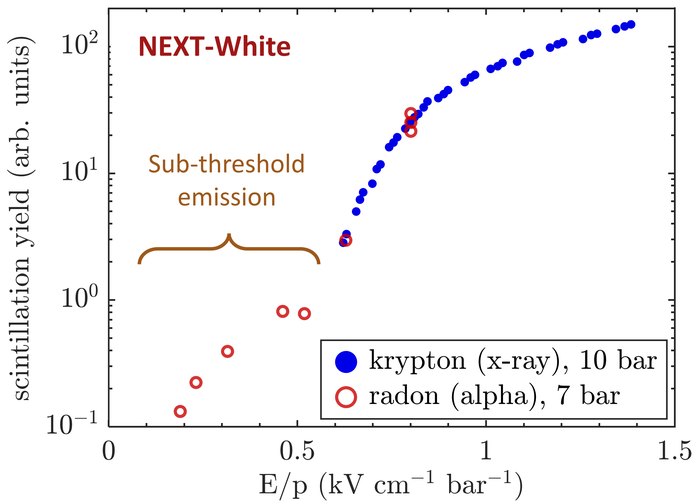
Introduction

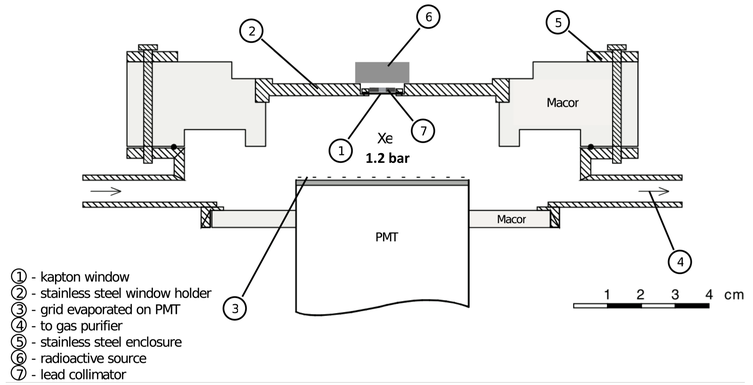
Neutral Bremsstrahlung (NBrS) emission in noble gases has been neglected in favour of excimer-based VUV emission. This alternative mechanism of secondary scintillation production was only recently unveiled in argon. **We have found strong evidence of neutral bremsstrahlung emission in xenon**, obtained 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 (GPSC).

1 - NEXT-White TPC

Alpha-particle runs in NEXT-White TPC revealed a non-negligible light production signal for low electric fields, under which drifting electrons have not sufficient kinetic energy to excite Xe atoms. For detailed studies on sub-threshold scintillation we employed a “driftless” GPSC under controlled conditions, allowing an accurate modulation of the wavelength-dependent geometrical efficiency.

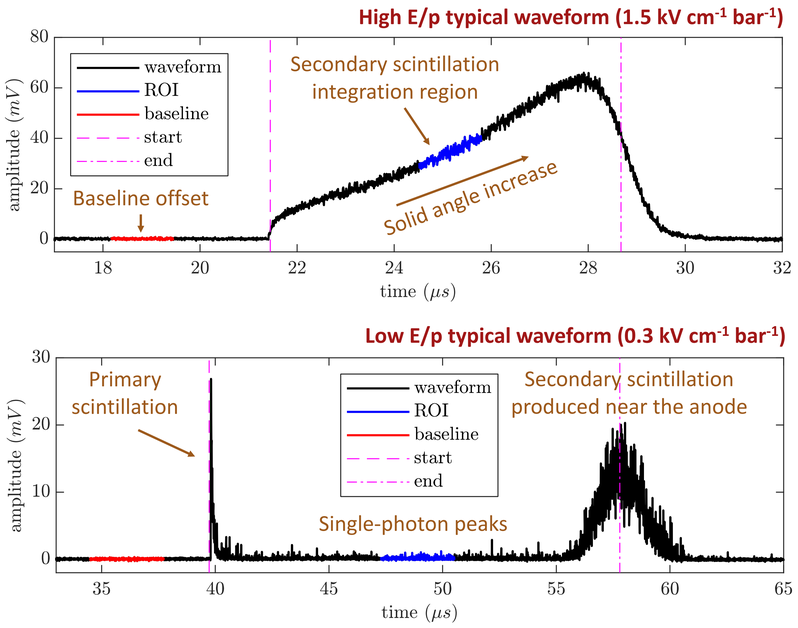


2 - Driftless-GPSC

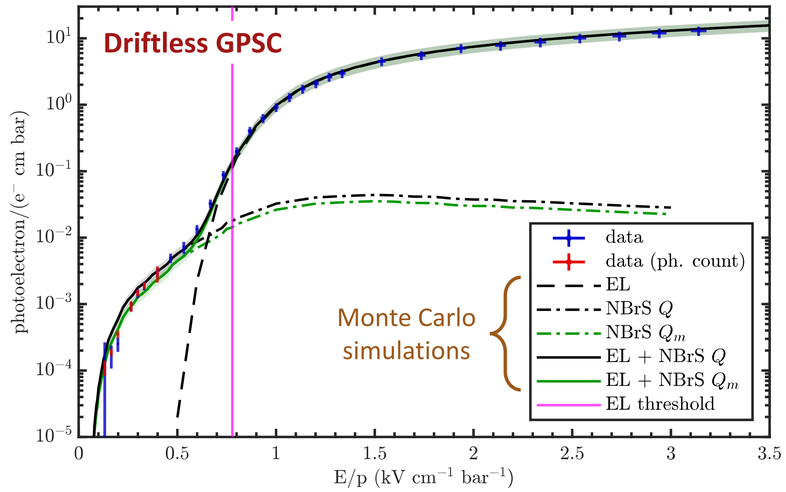


3 - Analysis method

The secondary scintillation yield is measured using the PMT waveforms produced by alpha-particles at different reduced electric fields (E/p). Single-photon statistics becomes possible for low E/p values.



4 - Experimental results



Comparison with first-principle calculations allows us to assign this sub-threshold emission to NBrS, which is intrinsically broadband and immune to quenching (unlike excimer-based scintillation), as verified in Xe-C_2H_6 mixtures.

Conclusions

- Despite being fainter than its excimeric counterpart, Neutral Bremsstrahlung causes luminous backgrounds that can interfere with the ability to measure low primary scintillation signals in either gas or liquid Xe TPCs.
- NBrS opens up a viable path towards the development of single-phase liquid Xe TPCs based on secondary scintillation amplification for neutrino and dark matter physics.

Acknowledgements

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