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Proton-proton correlations in ground-state two-proton radioactivity

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Away from the beta-stability valley, when nuclei become unbound towards emission of two protons ($2p$), ground-state $2p$ radioactivity becomes possible and is a characterising decay mode for even-Z elements beyond the $2p$ drip-line. It is this a very exotic decay mode, so far observed experimentally only for a handful of cases, for light and medium-mass isotopes with $Z \leq 36$ [1,2]. Simultaneous emission of $2p$ from nuclear ground states is indeed predicted to be observable for every even-Z element with $Z \leq 52$, i.e. up to tellurium isotopes. Beyond tellurium, sequential emission of the $2p$ is expected to dominate the decay of $2p$-unbound nuclei, rather than simultaneous.

In recent years, so-called discovery experiments, which identify new $2p$ emitting isotopes, have been complemented by precision studies to probe nuclear structure from $2p$-decay observables. In particular, momentum correlations between the two protons emitted are expected to bring a deeper insight into the initial wave function composition [1].
Several experimental and theoretical efforts are ongoing to shed light on the $Z = 28$ shell closure by looking at $p - p$ correlations in the three "classical" cases ^{45}Fe, ^{48}Ni, and ^{54}Zn.
In this contribution, an overview will be provided of the current status of this research.

[1] M. Pfützner, I. Mukha, S.M. Wang, Prog. in Part. and Nuclear Phys. 132 (2023) 104050.

[2] B. Blank and R. D. Page, Charged-Particle Radioactive Decays, in Handbook of Nuclear Physics, I. Tanihata et al. (eds.), Springer Nature Singapore Pte Ltd. 2023.

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