Constraining the two-proton radioactivity branch in ^{39}Ti*

V. Guadilla[1], F. de Oliviera[2], Z. Janas[1], Ł. Janiak[3], O. Kamalou[2], G. Kamiński[4], A. Korgul[1], A. Kubiela[1], C. Mazzocchi[1], K. Miernik[1], M. Pfützner[1], J. Piot[2], M. Pomorski[1], B. Rebeiro[2], A. Skruch[1], O. Sorlin[2], C. Stodel[2], M. H. Stodel[2], and J. C. Thomas[2]
[1]*Faculty of Physics, University of Warsaw, 02-093 Warsaw, Poland*
[2]*GANIL, CEA/DRF-CNRS/IN2P3, Boulevard Henri Becquerel, Caen, France*
[3]*National Centre for Nuclear Research, 05-400 Otwock, Świerk, Poland and*
[4]*Heavy Ion Laboratory, University of Warsaw, 02-093 Warsaw, Poland*

The ground state two-proton radioactivity (the simultaneous emission of two protons from even-Z very neutron-deficient nuclei) has been observed only in a few isotopes: ^{19}Mg [1], ^{45}Fe [2,3], ^{48}Ni [4], ^{54}Zn [5,6] and ^{67}Kr [7]. A better understanding of this exotic process requires the discovery of new cases. Theoretical predictions are essential to identify potential candidates, but they suffer from the lack of experimental data to tune and constrain the models. Nuclear masses play a key role, since the two-proton decay threshold of a given nucleus is determined from the nuclear binding energies.

In this contribution we will report on a recent experiment focused on the study of the possible two-proton radioactivity branch of ^{39}Ti, considered a promising candidate for direct two-proton decay (for recent surveys of potential two-proton cases see [8,9]). The ^{39}Ti ions were produced at GANIL by fragmentation of a ^{58}Ni primary beam at 74.5 MeV/nucleon impinging on a natural nickel target with a carbon stripper. The reaction products were identified in-flight with the LISE3 fragment separator [10] and implanted inside the Optical Time Projection Chamber (OTPC) developed at the University of Warsaw [11]. This detector allows one to reconstruct the charge-particle tracks and is insensitive to β electrons. It has been widely used to study two-proton radioactivity cases [2,12] and β-delayed multi-particle emission (for a recent example see [13]).

First results of this experiment will be presented in this contribution. In particular, the study of the β-delayed two-proton branch populating ^{37}K allows us to determine the mass excess of ^{39}Ti by means of the isobaric multiplet mass equation (IMME). This mass excess is employed to evaluate the energy window for two-proton radioactivity in ^{39}Ti, a critical input parameter for theoretical models. Predicted branching ratios will be discussed and compared with our experimental upper limit for direct observation of two-proton radioactivity.

[1] I. Mukha *et al.*, Phys. Rev. Lett. **99** (2007), 182501.
[2] M. Pfützner *et al.*, Eur. Phys. J. A **14** (2002), 279.
[3] J. Giovinazzo *et al.*, Phys. Rev. Lett. **89** (2002), 102501.
[4] M. Pomorski *et al.*, Phys. Rev. C **83** (2011), R061303.
[5] B. Blank *et al.*, Phys. Rev. Lett. **94** (2005), 232501.
[6] P. Ascher *et al.*, Phys. Rev. Lett. **107** (2011), 102502.
[7] T. Goigoux *et al.*, Phys. Rev. Lett. **117** (2016), 162501.
[8] J. Tian *et al.*, Phys. Rev. C **87** (2013), 014313.
[9] C. Ma *et al.*, Phys. Rev. C **102** (2020), 024330.
[10] R. Anne and A. C. Mueller, Nucl. Instrum. Methods B **70** (1992), 276.
[11] K. Miernik *et al.*, Nuclear Inst. Methods A **581** (2007), 194.
[12] K. Miernik *et al.*, Phys. Rev. Lett. **99** (2007), 19250.
[13] A. A. Ciemny *et al.*, Phys. Rev. C **106** (2022), 014317.

* Acknowledgements: We acknowledge the support of the National Science Center, Poland, under Contracts No. 2019/35/D/ST2/02081 and No. 2019/33/B/ST2/02908.