



Canadian Association  
of Physicists

Association canadienne  
des physiciens et physiciennes

Contribution ID: 3693 Type: **Oral Competition (Graduate Student) / Compétition orale (Étudiant(e) du 2e ou 3e cycle)**

## **(G\*) Bound-state beta-decay of Thallium-205 to constrain s-process predictions for the early Solar System**

*Monday 19 June 2023 11:15 (15 minutes)*

Bound-state  $\beta$ -decay ( $\beta_b^-$ -decay) is a radically transformative decay mode that can change the stability of a nucleus and generate temperature- and density-dependent decay rates. In this decay mode the  $\beta$ -electron is created directly in a bound atomic orbital of the daughter nucleus instead of being emitted into the continuum, so the decay channel is only significant in almost fully stripped ions during extreme astrophysical conditions. The  $\beta_b^-$ -decay of  $^{205}\text{Tl}^{81+}$  could influence our understanding of the production of  $^{205}\text{Pb}$ , a short-lived radioactive (SLR, 17.3 Myr) nucleus that is fully produced by the s-process in stars. In the context of the early Solar system, SLRs are defined by half-lives of 0.1-100 My and their abundance in meteorites can be used to constrain the formation of the Solar System [1]. Historically, it has been noted that thermal population of the 2.3 keV state of  $^{205}\text{Pb}$  in stellar conditions could dramatically reduce the abundance of s-process  $^{205}\text{Pb}$  by speeding up the EC-decay to  $^{205}\text{Tl}$ . This destruction of  $^{205}\text{Pb}$  is potentially balanced by the  $\beta_b^-$ -decay of  $^{205}\text{Tl}^{81+}$  [2]. Currently, a theoretical prediction for the half-life of fully stripped  $^{205}\text{Tl}$  is used in stellar models, but given the importance of the  $^{205}\text{Pb}/^{204}\text{Pb}$  chronometer, a measurement of the  $\beta_b^-$ -decay for  $^{205}\text{Tl}^{81+}$  was conducted at the GSI Heavy Ion Facility in March 2020. A  $^{205}\text{Tl}^{81+}$  beam was stored in the Experimental Storage Ring, and the growth of  $^{205}\text{Pb}^{81+}$  daughters with storage time was directly attributable to the  $\beta_b^-$ -decay channel. The authors will report a preliminary measured half-life and detail how this half-life can be used to more accurately predict the  $^{205}\text{Pb}$  abundance in the early Solar System.

[1] M. Lugaro, et al. *Progress in Particle and Nuclear Physics*, 102:1–47, 2018.

[2] K. Yokoi, et al. *Astronomy and Astrophysics*, 145:339–346, 1985.

### **Keyword-1**

nuclear astrophysics

### **Keyword-2**

s-process

### **Keyword-3**

exotic beta decay

**Author:** Mr LECKENBY, Guy (TRIUMF)

**Co-authors:** Mr SZÁNYI, Balázs (University of Szeged, Konkoly Observatory); Prof. MEYER, Bradley (Clemson University); GRIFFIN, Christopher; Dr VESCOVI, Diego (Goethe University Frankfurt); Prof. MARTINEZ-PINEDO,

Gabriel (GSI Heavy Ion Centre, Darmstadt Technical University); Dr WEICK, Helmut (GSI Heavy Ion Centre); DILLMANN, Iris; Dr GLORIUS, Jan (GSI Heavy Ion Centre); Prof. TAKAHASHI, Kohji (GSI Heavy Ion Centre); Dr PIGNATARI, Marco (Konkoly Observatory, University of Hull); Dr LUGARO, Maria (Konkoly Observatory, ELTE Eotvos Lorand University, Monash University); Dr SIDHU, Ragandeep Singh (University of Edinburgh, GSI Heavy Ion Centre); Dr MANCINO, Riccardo (Darmstadt Technical University, GSI Heavy Ion Centre); Dr CHEN, Rui Jiu (GSI Heavy Ion Centre); Dr CRISTALLO, Sergio (INAF - Abruzzo Astronomical Observatory); Ms KAUR, Tejpreet (Panjab University); Dr FAESTERMANN, Thomas (Munich Technical University); Dr NEFF, Thomas (GSI Heavy Ion Centre); Dr BATTINO, Umberto (University of Hull); Prof. LITVINOV, Yuri (GSI Heavy Ion Centre)

**Presenter:** Mr LECKENBY, Guy (TRIUMF)

**Session Classification:** (DNP) M1-4 Nuclear Astrophysics | Nucléaire astrophysique (DPN)

**Track Classification:** Technical Sessions / Sessions techniques: Nuclear Physics / Physique nucléaire (DNP-DPN)