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## Exciting the Hoyle state in $^{12}\text{C}$ selectively populated using the $^{10}\text{B}(^6\text{Li},^4\text{He})^{12}\text{C}$ reaction

An excited state in  $^{12}\text{C}$  close to the 3-alpha breakup was predicted by Fred Hoyle in 1954 and was identified in 1962 by Cook et al. as the  $0^+$  state lying at an excitation energy of 7.65 MeV. It was the key to understanding the production of  $^{12}\text{C}$  and heavier elements in the Sun (stars) up to iron. In the Sun's core, fusion of two alpha-particles leads to the production of excited  $^8\text{Be}$  and then the capture of another alpha-particle  $\alpha + ^8\text{Be}$  produces excited  $^{12}\text{C}$  close to the Hoyle state. Subsequently, gamma-decay from the Hoyle state to the  $4^+$  (4.43 MeV) state and down to the  $^{12}\text{C}$  ground state  $0^+$  (0.0 MeV) results in the production of stable  $^{12}\text{C}$ , as opposed to 3-alpha breakup. However, the observed enhanced  $^{12}\text{C}$  production rate in stars is speculated to be achieved through excited states of the Hoyle state. The existence of broad excited Hoyle states at  $^{12}\text{C}(2^+, 9.8 \text{ MeV})$  and  $^{12}\text{C}^*(4^+, 13.3 \text{ MeV})$  have been reported, previously not identified because of other nearby strongly excited states in  $^{12}\text{C}$ .

The  $^{10}\text{B}(^6\text{Li},\alpha)^{12}\text{C}^*$  reaction selectively excites  $2^+$  states in  $^{12}\text{C}$  and because of the high Q-value of  $Q = +24.6 \text{ MeV}$  the high energy alpha-particles are easily identified with good energy resolution. Measurements were taken at the EN Tandem Van de Graaff accelerator of iThemba LABS (Gauteng) using  $^6\text{Li}$  beams at  $E_{\text{Lab}} = 20 \text{ MeV}$  incident on thin  $^{10}\text{B}$  targets. Results will be presented for the observed high energy alpha-particles corresponding to states excited in  $^{12}\text{C}$  up to and above the Hoyle state. In addition, preliminary results will be shown for coincidence measurements between the outgoing high energy alpha-particle and the  $^{12}\text{C}$  reaction partner.

### Apply for student award at which level:

None

### Consent on use of personal information: Abstract Submission

Yes, I ACCEPT

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