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Rutherford and Tinsley: the beginning and middle of nucleosynthesis at the University of Canterbury

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Abstract. Two famous alumni of the physical sciences at the University of Canterbury were Ernest Rutherford (1890-1894) and Beatrice (Hill) Tinsley (1958-1963). They both had a significant impact on the study of the chemical elements in the laboratory as well as in stars. Their early Canterbury careers will be reviewed and then a brief review of their significant contributions to the understanding of the universe. This will be followed by a modern perspective, highlighting some more recent developments in the understanding of aspects of nucleosynthesis in stars.

Key words. nucleosynthesis – Rutherford – Tinsley

1. Introduction

This paper provides a brief introduction to the reason for holding one of the series of Torino Workshops at the University of Canterbury in Christchurch, New Zealand. The historical side of this is that the University of Canterbury is where Ernest Rutherford and Beatrice (Hill) Tinsley began their university careers as science students, although not in the fields for which they were later to become famous. However, since the late 1970s, nucleoastrophysics has been part of the research of staff and students at the University of Canterbury, making use of its high resolution spectrograph facilities at Mount John University Observatory and more recently the 11 m Southern African Large Telescope (SALT). The University of Canterbury joined this project as a founding shareholder that guarantees observing time on this facility.

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2. Rutherford

Ernest Rutherford completed a bachelors and masters degree at Canterbury College (now the University of Canterbury) during the period 1890 to 1894. He subsequently undertook graduate research work starting at the Cavendish Laboratory at the University of Cambridge in September 1895. This was followed by a professorial position at McGill University in Canada commencing in 1898 and then Langworthy Professor of Physics, Manchester University from 1907. He was finally appointed the 4th Cavendish Professor of Experimental Physics at University of Cambridge in 1919. And the Nobel Prize

Fig. 1. Rutherford's Nobel Medal for Chemistry in 1908 *for his investigations into the disintegration of the elements, and the chemistry of radioactive substances.*

Fig. 2. The New Zealand \$100 note, showing Rutherford, his 1908 Nobel Medal and the results of one of his radioactive decay experiments, an element he called ThX (which is Radium 224) that has a half-life of 3.66 days.

(see Figure 1) in December 1908 was for research work that Rutherford completed while at McGill.

The Nobel Medal is depicted on the New Zealand \$100 note (see Figure 2), along with an image of Rutherford at about the time he received this prize. There is also a decay and activation curve showing results for one of his radioactive decay experiments, that of ThX (see Rutherford & Soddy 1902).

There are several celebrations of Rutherford's accomplishments in New Zealand. One is Rutherford's Den

Fig. 3. The interior of Rutherford's Den in the Arts Centre, Christchurch, New Zealand.

in the Arts Centre in Christchurch (http://www.rutherfordsden.org.nz and Figure 3) and another is *Rutherford Scientist Supreme* by John Campbell, a biography that begins with Rutherford's early life, schooling and undergraduate career at Canterbury College as well as his later career (Campbell 1999).

Rutherford had a research career extending from 1894 with his first publication (Rutherford 1894) through to his final research publication in 1937 (Rutherford 1937). And there were a number of papers which relate directly to the topics of this meeting, namely nucleosynthesis of the elements and the age of heavenly bodies (Rutherford 1929).

3. Beatrice Hill Tinsley

Beatrice Hill Tinsley started at the University of Canterbury in 1958, completing her BSc at the end of 1960 with majors in Physics and Pure Mathematics. She then continued with a Masters in Physics at Canterbury, completing this with First Class Honours with a thesis entitled, *Theory of the crystal field in Neodymium Magnesium Nitrate* in late 1962. She was an outstanding scholar and had a number of grades in the nineties (out of 100) and even 4 (out of 19) courses with perfect scores. All but one course had a mark in the nineties. Beatrice also obtained many prizes as an undergraduate and graduate student while at Canterbury.

Subsequent to this study at Canterbury, Beatrice went to the United States and undertook her PhD thesis research at the University of Texas at Austin and completed it in about two years.

Her relatively short research career, cut short by her death at age 40 from melanoma, was punctuated by many papers in areas related to chemical evolution in stars and galaxies, for example Schramm & Tinsley 1974 and Tinsley 1980. And her research continued right up until her death with the following editorial tribute in Tinsley 1981, saying *deceased on 1981 March 23, thus ending prematurely a distinguished career.*

4. Beyond Rutherford and Tinsley

Modern astronomy research began at the University of Canterbury in the 1960s, but the study of elemental abundances using facilities at Mount John University Observatory didn't begin until John Hearnshaw arrived at Canterbury in 1977. His work used an echelle spectrograph that was installed on one of Mt John's 61cm telescopes. This developed further with the author's arrival in 1982 and there have been a succession of graduate students and some key instrument developments that have enabled the elemental abundance theme to be continued.

Additional academic staff in observational astrophysics joined the faculty, William Tobin in 1987 (until 2006) and Michael Albrow and Karen Pollard in 2001. Canterbury researchers have also made use of facilities at other observatories (particularly in Australia) to extend their analyses to fainter objects. The final accomplishment of the astronomy academic staff at Canterbury has been the key foundation shareholding in the SALT facility in South Africa. Cottrell and Albrow were part of a team that included graduate student Stuart Barnes and engineer Graeme Kershaw that designed the high-resolution spectrograph for SALT (Buckley et al. 2006). This instrument is now being constructed at Durham University to the University of Canterbury design.

Elsewhere in these proceedings Worley & Cottrell 2010 will discuss some of the recent results of studies of stars in globular clusters 47 Tuc (Worley et al. 2009) and NGC 362 and NGC 6388 stars (Worley et al. 2010; Worley & Cottrell 2010).

5. Conclusion

This paper has presented a brief overview of the early undergraduate and graduate students careers of Ernest Rutherford and Beatrice Hill Tinsley at the University of Canterbury and their subsequent rise to be leaders in fields that motivates our research in AGB star nucleosynthesis. Finally, some more recent work being carried out by researchers at the University of Canterbury was highlighted.

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