# Challenges in Describing Fusion: Pointers to Future Developments from Precision Measurements

M. Dasgupta[1]

[1]*Department of Nuclear Physics, Australian National University, ACT 2601, Australia*

Experiments that followed the advent of heavy ion accelerators in the 1980s led to the understanding that nuclear structure of the colliding nuclei strongly affect fusion outcomes [1, 2]. New experimental techniques used in 1990s, that led to precision measurements, cemented this understanding further through the concept of experimental barrier distributions [3] that in particular highlighted the role of collective states [4]. Since the 2000s however, deficiencies in our understanding were beginning to emerge with precision data available for a larger number of systems [5], cross-section measurements to deep sub-barrier energies [6–8], and more recently through the measurements of reflected flux [9, 10]. During this period new theories have been put forward to explain specific results, but with limited predictive power. In the last decade microscopic theories have been advanced which give us deeper insights into the fusion process. However, applications to the sub-barrier region still requires a barrier passing model to be used. The main challenge lies in consistently explaining the deep sub-barrier fusion cross-section together with above barrier fusion cross-sections and the observed reflected flux. This talk will discuss measurements made in the last few years that provide evidence that some fundamental physical process is not being modelled correctly.

---

[1] M. Beckerman, *Rep. Prog. Phys.* **51**, 1047 (1988).
[2] C.H. Dasso et al., *Nucl. Phys. A* **407**, 221 (1983).
[3] N. Rowley et al., *Phys. Lett. B* **254**, 25 (1991).
[4] M. Dasgupta et al., *A*nnu. Rev. Nuc. Part. Sci. **48**, 401 (1998).
[5] J. O. Newton et al., *P*hys. Rev. C **70**, 024605 (2004).
[6] C. L. Jiang et al., *Phys. Rev. Lett.* **93**, 012701 (2004).
[7] A. M. Stefanini et al., *Phys. Rev. C* **82**, 014614 (2010).
[8] B.B. Back et al., *Rev. Mod. Phys.* **86**, 317 (2014).
[9] M. Evers et al., *P*hys. Rev. C **84**, 054614 (2011).
[10] D. C. Rafferty et al., *P*hys. Rev. C **94**, 024607 (2016).