Multilinear analysis of the proton decay systematics and its uncertainty

Mario B. Amaro, Chong Qi[1]
[1] *KTH Royal Institute of Technology, SE-10691 Stockholm, Sweden*

There exists a striking linear correlation in alpha decay systematics between the logarithm of the decay half-lives and the energies of the outgoing particles. This is known as the Geiger-Nuttall law which works extremely well describing alpha as well as heavier cluster decays even today. Theoretically, one would expect the proton radioactivity to follow the same tunnelling process. But there has been no success in finding a simple linear pattern in proton decay half-life systematics [1,2]. Instead, the available proton decay data seem to follow roughly two lines with quite large errors. In addition, there are quite a few data falling in between the lines. That makes it difficult not only for having a reliable prediction on the decay half-life but also for understanding the physics behind.

In this contribution, we describe the proton decay as a two-step process: The formation of the decaying orbital and the tunnelling through the Coulomb and centrifugal barriers. The later can be calculated analytically. As a result we can extract the proton formation amplitude, which reflects the overlap between the mother, daughter and decaying proton wave functions, from experimental decay half-lives and Q values in a model independent way. The formation amplitude thus extracted can be further expressed in a particle decay unit [3]. We will show that all proton formation amplitudes (and thus decay half-lives) can be described extremely well by a simple multilinear model with only three parameters [4]. The statistic and systematic errors of the model prediction will also be discussed based on variance anlysis and Bayesian analysis.

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