Neutron-proton and neutron-neutron quasi-free scattering in the d+n breakup reaction at 25.8 MeV.

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Besides the n-n final-state interaction the only other direct way to investigate the interaction between two neutrons is quasi-free scattering (QFS), most favorably studied in the n-d breakup reaction. Both for n-n and n-p QFS very few data exist at energies where rigorous three-body calculations are available, the reasons being mainly experimental ones: since in the ^{2}H(n,2n)p reaction the spectator proton does not produce a usable target signal, the energies of the two neutrons must be determined by means of their time-of-flight (TOF) with respect to the r.f. signal from the accelerator while for n-p QFS, a thin target must be used which necessitates an intense neutron beam and long running times.
We have measured both n-p and n-n QFS at 25.8 MeV with a total experimental error of approximately 3 % in each case. While the theory reproduces the experimental data nicely for n-p QFS, there is a large discrepancy between theory and experiment in the case of n-n QFS which far exceeds any conceivable experimental uncertainty. This is even more striking in view of the fact that in a previous experiment, in which the n-p scattering length was measured using the same reaction and essentially the same experimental setup, the difference between the predicted and measured yield was less than 1 % [1]. We thus have to conclude that the n-d breakup cross section in the region of n-n QFS is not predicted correctly by the theory at 25.8 MeV.

[1] V. Huhn, L. Wätzold, C. Weber, A. Siepe, W. von Witsch, H. Witała and W. Glöckle, Phys. Rev. **C 63**, 014003 (2001).