Public Abstract
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For convenient use of energy, it is common to use chemical potential energy stored in a fuel. To reduce pollution, a desirable fuel is molecular hydrogen, whose only byproduct is water vapor. However, there are still many obstacles that must be overcome for it to become widely used; the most significant is its storage. Despite having high energy content per by weight, hydrogen has very low energy content per volume, traditionally requiring high pressures and/or low temperatures to store. One proposed method is via physical adsorption to some high surface area material. However, current materials are still far from meeting Department of Energy goals.

This work discusses improvements to some traditionally less reliable techniques used to characterize adsorbants. The isosteric heat of adsorption, which is the heat released by hydrogen as adsorbed, is an important value because of its relation to the binding energy. It can be estimated from adsorption isotherms or measured directly, but each methods is of limited applicability and requires care to determine accurately. Inelastic neutron scattering is a technique which scatters neutrons from the adsorbed hydrogen molecules, with the resultant energy loss giving direct information about the quantum states. This work establishes a theoretical basis for improved analysis of the spectra and applies it to experimental data.

A case study is presented on a sample with quite high adsorption for its surface area, both at cryogenic and room temperatures, which also has a number of other unusual characteristics. The experimental data for the sample does not fit with classical adsorption theory, suggesting some new phenomena at work. Several hypotheses are presented. One, which takes advantage of the bosonic nature of the composite molecular hydrogen particle, seems to be the most able to offer a complete explanation for the behavior of the sample.