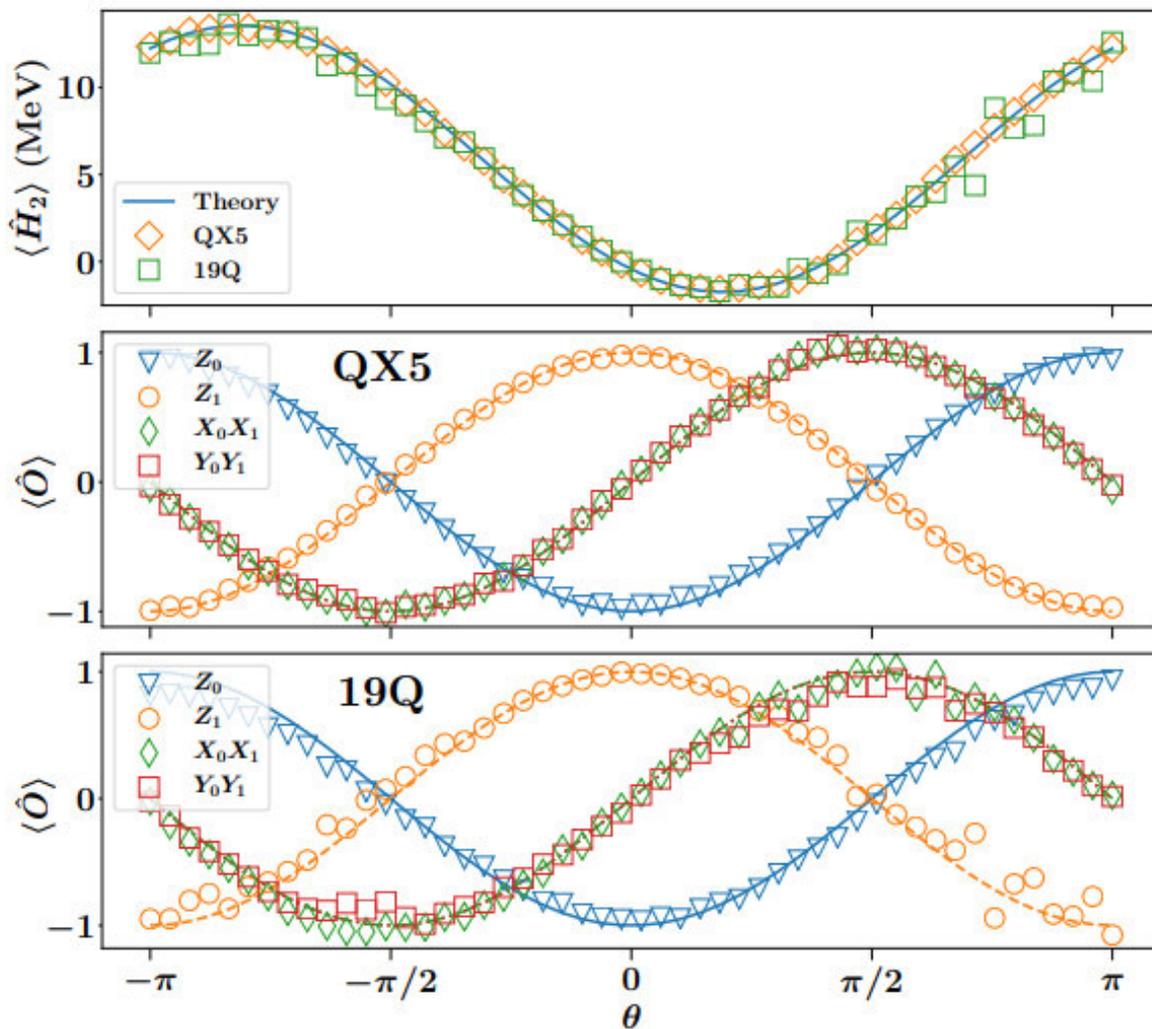


# Cloud based quantum computing used to calculate nuclear binding energy

February 2 2018, by Bob Yirka



Experimentally determined energies for H2 (top) and expectation values of the Pauli terms that enter the two-qubit Hamiltonian  $H_2$  as determined on the QX5 (center) and 19Q (bottom) chips. Experimental (theoretical) results are denoted

by symbols (lines). Credit: arXiv:1801.03897 [quant-ph]

A team of researchers at Oak Ridge National Laboratory has demonstrated that it is possible to use cloud-based quantum computers to conduct quantum simulations and calculations. The team has written a paper describing their efforts and results and uploaded it to the *arXiv* preprint server.

As work progresses toward the development of quantum computers able to tackle some of the most difficult problems in computer science, attention has shifted to the means by which such machines would be used. For example, if researchers build a big, expensive quantum computer able to model how atoms and particles behave under unusual conditions, how would research physicists access and use it? That has led to the idea of cloud [quantum computing](#) so that anyone could access and use it from practically anywhere. That idea has been put into practice by two companies investing seriously in a quantum computer-based future. IBM has developed what it calls Q Experience, and Rigetti has developed 19Q. The former has a [quantum processor](#) with 16 qubits while the later has 19. In addition to building their computers, both companies have also developed software that makes the systems available on the internet.

To test the possibilities of such a platform, the team at Oak Ridge set themselves the task of using a quantum computer to calculate the nuclear binding energy of the deuterium nucleus (how much energy it would take to separate the neutron and proton). The team used both cloud quantum computing systems, which required tweaking software to deal with the differing number of qubits the machines were able to use. The team reports that the cloud responded with a binding energy that was within 2 percent of the actual measure.

The researchers report that their efforts prove that cloud-based quantum computing works, and that it will be ready for prime-time when truly powerful machines are developed capable of such tasks as simulating quantum physical systems or revealing reaction mechanisms in complex chemical systems.

**More information:** Cloud Quantum Computing of an Atomic Nucleus, arXiv:1801.03897 [quant-ph] [arxiv.org/abs/1801.03897](https://arxiv.org/abs/1801.03897)

### **Abstract**

We report a quantum simulation of the deuteron binding energy on quantum processors accessed via cloud servers. We use a Hamiltonian from pionless effective field theory at leading order. We design a low-depth version of the unitary coupled-cluster ansatz, use the variational quantum eigensolver algorithm, and compute the binding energy to within a few percent. Our work is the first step towards scalable nuclear structure computations on a quantum processor via the cloud, and it sheds light on how to map scientific computing applications onto nascent quantum devices.

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