CLAIMS

1. A system for globally controlling one or more qubits, the system comprising:

a quantum processor comprising a plurality of spin-based qubits; and

a dielectric resonator positioned adjacent to the quantum processor, the dielectric resonator being formed of a dielectric material having a dielectric constant that increases at a cryogenic temperature relative to at room temperature,

wherein the dielectric resonator is configured to operate at the cryogenic temperature, and with an operating frequency determined by the dielectric constant and a resonant mode volume of the dielectric resonator, to:

receive, from a coupler, an input signal; and

generate, in response to receiving the input signal, a global AC magnetic field at the operating frequency that extends from the dielectric resonator to the quantum processor to control an electron spin or a nuclear spin of one or more of the spin-based qubits.

2. The system of claim 1, wherein the cryogenic temperature is less than or equal to 4 Kelvin.

3. The system of any one of claims 1 or 2, wherein the dielectric constant of the resonator is in a range of 1000 to 40,000 at the cryogenic temperature.

4. The system of any one of claims 1 to 3, wherein the global AC magnetic field controls a single qubit of the quantum processor.

5. The system of any one of claims 1 to 3, wherein the global AC magnetic field simultaneously controls a plurality of qubits of the quantum processor.

6. The system of any one of claims 1 to 5, wherein the dielectric resonator produces an electric field spatially separated from the global AC magnetic field.

7. The system of claim 6, wherein the global AC magnetic field of the dielectric resonator is perpendicular to a surface of the dielectric resonator and is directed outwardly of the surface of the dielectric resonator.

8. The system of claim 7, wherein the electric field is confined away from a position of the quantum processor for minimising the interaction of the electric field with the one or more spin-based qubits, and on-chip measurement and control electronics of the quantum processor.

9. The system of claim 8, wherein the electric field circulates within the dielectric resonator.

10. The system of any one of claims 1to 9, wherein the dielectric resonator is made of a material from a class of compounds having a perovskite structure ($^{XII}A^{2+VI}B^{4+}X^{2-}{}_3$).

11. The system of claim 10, wherein the dielectric resonator is made of potassium tantalate ($KTaO_3$) or strontium titanate ($SrTiO_3$).

12. The system of any one of claims 1 to 11, wherein the resonant mode volume of the dielectric resonator is approximately 5×10^{-7} m^3.

13. The system of any one of claims 1 to 12, wherein the quantum processor is a solid-state semiconducting or superconducting quantum processor.

14. The system of any one of claims 1 to 13, wherein the dielectric resonator is in the form of a solid block of a dielectric material and the quantum processor is positioned either above or below the dielectric resonator such that the one or more spin-based qubits of the quantum processor face towards the dielectric resonator to interact with the global AC magnetic field provided by the dielectric resonator.

15. The system of any one of claims 1 to 14, wherein the dielectric resonator is separated from the quantum processor by a low microwave loss tangent material or by vacuum space.

16. The system of any one of claims 1 to 15, wherein the coupler is a coaxial cable, a lithographically-defined coupler, or a waveguide and iris.

17. The system of any one of claims 1 to 16, wherein the frequency of the global AC magnetic field produced by the dielectric resonator is in radio frequency range from 1.0 MHz to 1.0 GHz for controlling nuclear spins.

18. The system of any one of claims 1 to 16, wherein the frequency of the global AC magnetic field produced by the dielectric resonator is in microwave frequency range which is in a range of 1.0 GHz to 100.0 GHz for controlling electron spins.

19. A method for globally controlling a plurality of qubits using the system of any one of claims 1 to 18.