

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau

(43) International Publication Date
29 October 2020 (29.10.2020)



(10) International Publication Number
WO 2020/216578 A1

(51) International Patent Classification:
G06N 10/00 (2019.01)

(21) International Application Number:
PCT/EP2020/058801

(22) International Filing Date:
27 March 2020 (27.03.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/838,148 24 April 2019 (24.04.2019) US
16/542,094 15 August 2019 (15.08.2019) US

(71) Applicant: **INTERNATIONAL BUSINESS MACHINES CORPORATION** [US/US]; New Orchard Road, Armonk, New York, 10504 (US).

(71) Applicant (for MG only): **IBM UNITED KINGDOM LIMITED** [GB/GB]; PO Box 41, North Harbour, Portsmouth Hampshire PO6 3AU (GB).

(72) Inventors: **CROSS, Andrew**; IBM CORPORATION, PO BOX 218, 1101 KITCHAWAN RD, YORKTOWN HEIGHTS, New York, New York 10598 (US). **CHAMBERLAND, Christopher**; IBM CORPORATION, PO BOX 218, 1101 KITCHAWAN ROAD, YORKTOWN HEIGHTS, New York, New York 10598 (US). **GAMBETTA, Jay, Michael**; IBM CORPORATION, PO BOX 218, 1101 KITCHAWAN RD, YORKTOWN HEIGHTS, New York, New York 10598 (US). **HERTZBERG, Jared**; IBM CORPORATION, PO BOX 218, 1101 KITCHAWAN RD, YORKTOWN HEIGHTS, New York, New York 10598 (US). **YODER, Theodore**; IBM CORPORATION, PO BOX 218, 1101 KITCHAWAN RD, YORKTOWN HEIGHTS, New York, New York 10598 (US). **ZHU, Guanyu**; IBM CORPORATION, PO BOX 218, 1101 KITCHAWAN RD, YORKTOWN HEIGHTS, New York, New York 10598 (US).

(74) Agent: **WILLIAMS, Julian**; IBM United Kingdom Limited, Intellectual Property Law, Hursley Park, Hursley, Winchester Hampshire SO21 2JN (GB).

(54) Title: QUANTUM CODE FOR REDUCED FREQUENCY COLLISIONS IN QUBIT LATTICES

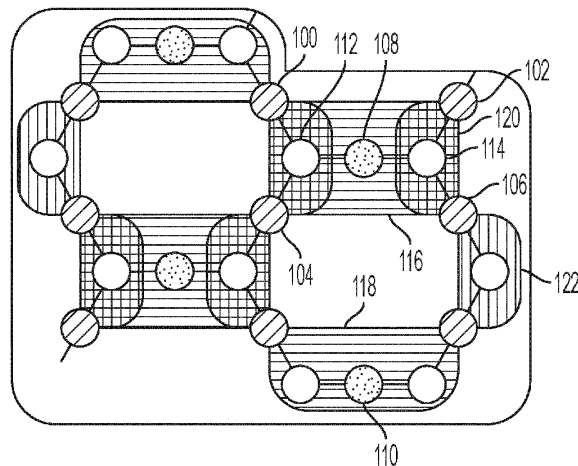


FIG. 1

(57) Abstract: A quantum computer includes a quantum processor that includes a first plurality of qubits arranged in a hexagonal lattice pattern such that each is substantially located at a hexagon apex, and a second plurality of qubits each arranged substantially along a hexagon edge. Each of the first plurality of qubits is coupled to three nearest-neighbor qubits of the second plurality of qubits, and each of the second plurality of qubits is coupled to two nearest-neighbor qubits of the first plurality of qubits. Each of the second plurality of qubits is a control qubit at a control frequency. Each of the first plurality of qubits is a target qubit at one of a first target frequency or a second target frequency. The quantum computer includes an error correction device configured to operate on the hexagonal lattice pattern of the plurality of qubits so as to detect and correct data errors.

[Continued on next page]

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))