

WHAT IS CLAIMED IS:

1. A non-transitory computer-readable storage medium comprising stored instructions that, when executed by a computing system, cause the computing system to perform operations including:
 - determining first and second parameter sets for a quantum program;
 - dispatching the quantum program with the first and second parameter sets to a quantum processing queue of a quantum information processing unit (QIPU), the quantum processing queue configured to store quantum programs for execution by the QIPU;
 - receiving a first expectation value of the quantum program executed by the QIPU with parameters of the first parameter set;
 - while the QIPU evaluates a second expectation value of the quantum program with parameters of the second parameter set, computing a third parameter set for the quantum program based on the first parameter set and the first expectation value; and
 - modifying the quantum processing queue by dispatching the quantum program with the third parameter set to the quantum processing queue.
2. The non-transitory computer-readable storage medium of claim 1, wherein the operations further include:
 - receiving the second expectation value of the quantum program executed by the QIPU with parameters of the second parameter set;
 - while the QIPU evaluates a third expectation value of the quantum program with parameters of the third parameter set, computing a fourth parameter set for the quantum program based on the first and second parameter sets and the first and second expectation values; and
 - modifying the quantum processing queue by dispatching the quantum program with the fourth parameter set to the quantum processing queue.
3. The non-transitory computer-readable storage medium of claim 1, wherein the operations further include:
 - while the QIPU evaluates the first expectation value of the quantum program with parameters of the first parameter set or a third expectation value of the quantum program with parameters of the third parameter set, computing a parameter set for a second quantum program; and

modifying the quantum processing queue by dispatching the second quantum program with the parameter set of the second quantum program to the quantum processing queue.

4. The non-transitory computer-readable storage medium of claim 1, wherein the QIPU is one of a set of QIPUs and the quantum processing queue is configured to store quantum programs each for execution by one or more QIPUs of the set.

5. The non-transitory computer-readable storage medium of claim 4, wherein dispatching the quantum program with the third parameter set further includes dispatching an instruction for the quantum program with the third parameter set to be executed by the QIPU.

6. The non-transitory computer-readable storage medium of claim 4, wherein dispatching the quantum program with the third parameter set further includes dispatching an instruction for the quantum program with the third parameter set to be executed by a QIPU with a noise profile that is substantially the same as a noise profile of the QIPU.

7. The non-transitory computer-readable storage medium of claim 1, wherein modifying the quantum processing queue comprises adding the third parameter set to an end of the quantum processing queue.

8. The non-transitory computer-readable storage medium of claim 1, wherein modifying the queue comprises instructing the QIPU to cease a current execution and to evaluate an expectation value of the quantum program with parameters of the third parameter set.

9. The non-transitory computer-readable storage medium of claim 1, wherein the quantum program is a quantum circuit of a variational optimization problem and the third parameter set corresponds to a next variational step.

10. The non-transitory computer-readable storage medium of claim 1, responsive to the quantum processing queue having less than a threshold number of programs, re-dispatching the quantum program with the first parameter set to the quantum processing queue.

11. A method comprising:
generating a set of quantum programs;
dispatching at least some of the set of quantum programs to multiple quantum information processing units (QIPU) for execution;
asynchronously receiving results generated by the multiple QIPUs in a streaming or batched fashion;

performing single or multithreaded generation of a new set of quantum programs based on the returned results; and
dispatching at least some of the new set of quantum programs to the multiple QIPUs for execution.

12. The method of claim 11, further comprising processing, by the multiple quantum information processing units, the dispatched programs.

13. The method of claim 11, wherein the set of quantum programs are generated by a classical controller by optimizing an objective function for a variational quantum program execution.

14. The method of claim 11, wherein dispatching at least some of the new set of quantum programs comprises sending an instruction to at least one QIPU to cease a current quantum program process and to process a quantum program of the new set.

15. A quantum processing system comprising:

one or more controllers configured to:

calculate a series of initial parameter sets for a quantum program;

dispatch the quantum program with the series of initial parameter sets to a quantum processing queue;

receive a first expectation value corresponding to the quantum program with parameters of a first initial parameter set;

compute a next parameter set based on the first initial parameter set and first expectation value; and

dispatch the next parameter set to the quantum processing queue; and

a quantum information processing unit (QIPU) configured to:

evaluate the first expectation value for the quantum program with parameters of the first initial parameter set;

broadcast the first expectation value to the one or more controllers;

while the next parameter set is being computed, evaluate a second expectation value for the quantum program with parameters of a second initial parameter set;

receive the next parameter set; and

evaluate a next expectation value for the quantum program with parameters of the next parameter set.

16. The quantum processing system of claim 15, wherein the quantum processing unit is further configured to cease evaluation of the second expectation value prior to completion responsive to receiving the next parameter set.

17. The quantum processing system of claim 15, wherein the QIPU is one of a set of QIPUs and the quantum processing queue is configured to store quantum programs for execution by QIPUs of the set.

18. The quantum processing system of claim 17, wherein dispatching the next parameter set further includes dispatching an instruction for the quantum program with the next parameter set to be executed by the QIPU.

19. The quantum processing system of claim 17, wherein dispatching the next parameter set includes dispatching an instruction for the quantum program with the next parameter set to be executed by a QIPU with a noise profile that is substantially identical to a noise profile of the QIPU.

20. The quantum processing system of claim 15, wherein the one or more controllers are further configured to, responsive to the quantum processing queue having less than a threshold number of programs, re-dispatch the quantum program with the series of initial parameter sets to the quantum processing queue.