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**Investigating Runtime Optimization on the PTMCMC Gravitational Wave Algorithm using GPU Acceleration with CUDA**

The research goal was to optimize the running time of a parameter estimation (PE) used to estimate the masses and other parameters of colliding black holes from their gravitational waves. The challenge was that the algorithm’s running time on an average CPU processor (Intel i7) would bottleneck in the loop over trig-functions *sin* and *cos*. Before optimizing, running 1,000,000 iterations with a 16384 sample rate the average runtime on the CPU was **3hrs 32min 11sec**. When the loop was converted to a CUDA algorithm (with same parameter conditions as above) for use by a GPU, the average runtime was **2hrs 4min 11sec**. CUDA allows for the removal of the loop altogether and turns it into a one line kernel execution. This kernel execution sends a piece of code to the GPU to be processed and returned. In essence, instead of running a line of code serially with the CPU, the GPU sends the same line of code to multiple *threads* on its multiprocessors and computes them in parallel. This increase in productivity averages at about 22%. Overall, using CUDA with any current GPU can easily optimize the PE algorithm because it utilizes efficient multithreading/parallelism to decrease overall processing runtime and requires minimal changes to the source code.