Abstract Submitted
for the APR10 Meeting of
The American Physical Society

Pulsar Timing Arrays Can Measure Gravitational Wave Source Distance XIHAO DENG, LEE SAMUEL FINN, Department of Physics, The Pennsylvania State University, University Park PA 16802 — Gravitation waves manifest themselves as a tidal acceleration; correspondingly, gravitational wave detectors must be analyzed as (space-time) extended systems interacting with a (space-time) extended wave. In the case of pulsar timing arrays the detector size is of order the pulsar-Earth distance, which is in excess of 1 Kpc for over half the pulsars in the International Pulsar Timing Array (IPTA). For a gravitational wave point source the radiation wavefront curvature, associated with the finite source-Earth distance, leads to timing corrections of magnitude $(h/f)\sin(\pi f L^2/R)$, where h is the gravitational wave strain amplitude, L the pulsar-Earth distance, R the source-Earth distance, and f the characteristic gravitational wave frequency. The timing precision of the best IPTA pulsars are better than 100 ns rms; correspondingly pulsar timing array observations should be capable of measuring the timing parallax distance to point gravitational wave sources at cosmological distances.

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Date submitted: 29 Nov 2009 Electronic form version 1.4