Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Acoustic Echoes in Model Glasses JUSTIN BURTON, SIDNEY NAGEL, The University of Chicago — At low temperatures, glasses and crystals behave in qualitatively different ways. In particular, glasses have a great many more low-energy excitations that have traditionally been explained in terms of a distribution of dilute, two-level quantum states that are created by clusters of particles tunneling between two nearly degenerate ground states. Strong evidence for this model has come from the saturation effects and acoustic echoes [1] observed in these excitations. We show that, in contrast to conventional wisdom, the quasi-localized, strongly anharmonic, normal modes of jammed systems [2] can produce acoustic echoes due to the shift in the mode frequency with increasing amplitude. We observe this both in jammed packings of spherical particles with finite-range, Hertzian repulsions, and in model glasses interacting with a Lennard-Jones potential. In contrast to pulse echoes in two-level systems, a distinguishing feature of these "anharmonic echoes" is the appearance of multiple echoes after two excitation pulses, a feature also observed in experiments [1].

[1] B. Golding and J. E. Graebner. Phys. Rev. Lett. **37**, 852 (1976).
[2] N. Xu, V. Vitelli, A. J. Liu, and S. R. Nagel. Europhys. Lett. **90**, 56001 (2010).

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Date submitted: 21 Nov 2011 Electronic form version 1.4