Elastic waves interaction in icosahedral Al Pd Mn

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Quasicrystals exhibit a long-range orientational order and are fundamentally anisotropic. However, in icosahedral quasicrystals, this order does not generally show up at the macroscopic level because the icosahedral symmetry induces the isotropy of the commonly observed physical properties. More precisely, it can be shown that a macroscopic property can exhibit anisotropy only if it is described by a N-rank tensor with $N \geq 5$. To probe this point, we have studied the nonlinear properties of acoustic waves, a phenomenon which depends on a sixth-rank tensor (so called, third-order elastic constants). The sample is an icosahedral Al Pd Mn single domain. We studied both transverse and longitudinal acoustic waves. The behavior of the transverse waves clearly shows that the nonlinear elastic properties are anisotropic. We observed that transverse waves generate second harmonic transverse waves. This process is forbidden in an isotropic solid and is a clear manisfestation on a macroscopic scale of the long-range order in quasicrystals[1]. Those experiments have been complemented by a study of the interaction of longitudinal waves. Two collinear longitudinal waves with different frequencies propagate successively in the sample and in a reference liquid. Their interaction in both media produces sum and difference frequency waves. Quantitative informations on the third-order elastic constants is then derived thanks to a comparison method.

[1] J.-Y. Duquesne and B. Perrin, Phys. Rev. Lett., **85**, 4301 (2000)