# Tunneling States in Crystals with Large Unit Cell

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The low temperature (T<1K) properties of amorphous solids are explained by the presence of specific excitations which result from a tunneling effect of atoms between different configurations[1]. These low-energy excitations, called tunneling states (TS's), are not found in simple crystals like quartz. To understand the microscopic nature of these TS's it is important to study materials with an intermediate structure between the simple crystalline structure of quartz and the amorphous structure of glasses.

Different studies on high quality quasicrystals showed that TS's exist in materials with an orientational long range order but no periodic order[2-4]. Therefore, we have undertaken the study of crystals with a high number of atoms in their unit cell. Indeed, if in a crystal one increases the number of atoms in the unit cell one can hope to find within the cell some neighbouring configurations for tunneling.

The presence of TS's drastically changes the variation of the acoustic velocity below about 1K. It increases logarithmically with temperature and the slope is directly proportional to the TS density of states. So we have performed acoustic measurements down to 15mK on four different monocrystalline samples: a single crystal of olivine (28 at/cell), a single crystal of cordierite (116 at/cell), a single crystal of quartz (test sample) and since we expected the results to be more general than in the particular case of mineral crystals we have also studied a metallic compound. We have chosen a single crystal of the cubic approximant R-$Al_5CuLi_3$ which has a large unit cell (around 160 at/cell) and a complex local order (which is close to the one of the related quasicrystal i-AlCuLi).

As expected no TS's was found in the quartz sample. The olivine sample revealed a very small amount of TS's with a gap in their density of states at low energy. In both the cordierite and the metallic sample the results were qualitatively amourphous-like with a small density of states of TS's. In the cordierite sample we could also observe phonon echoes which gives another strong evidence for the presence of TS's in this sample.

In conclusion of this work, a random network does not seem necessary for the existence of TS's. If the number of atoms in the unit cell is high enough, there can be for some groups of atoms two slightly different configurations and tunneling can happen between these ones.

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