## Dynamic Ordering and Lattice Orientation of Driven Vortex Matter

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We study the lattice orientation of driven vortex lattices based on the mode-locking (ML) resonance. The lattice orientation with respect to the flow direction is either parallel or perpendicular to one side of triangles, while it is not trivial which orientation the driven vortex lattice favors. An earlier theory based on an idea of the least power dissipation showed that at large velocities the motion of vortices is parallel to their nearest-neighbor direction. Our recent ML experiment on amorphous films performed at moderate velocities has shown compelling evidence for the perpendicular orientation, indicative of dynamic pinning effects.[1] However, under increasing the velocity, switching of the lattice orientation from perpendicular to parallel is visible at the field-dependent threshold velocity. Interestingly, at the threshold, the characteristic time for the vortex to travel one lattice spacing is independent of the field or lattice constant; it nearly coincides with the quasiparticle recombination time reported from tunneling measurements. The results imply that, to realize the parallel orientation, the velocity of the moving lattice must be large enough that the following vortex remembers the presence of the preceding one. We also present novel dynamic transitions observed at low velocities prior to dynamic ordering.[2]

[1] S. Okuma *et al.*, Phys. Rev. B **83**, 064520 (2011): **80**, 132503 (2009): **80**, 220501(R) (2009).
[2] S. Okuma, Y. Tsugawa, and A. Motohashi, Phys. Rev. B **83**, 012503 (2011).