

Evidence of Vortex–Antivortex in the pinned layer of a nanocontact vortex based oscillator

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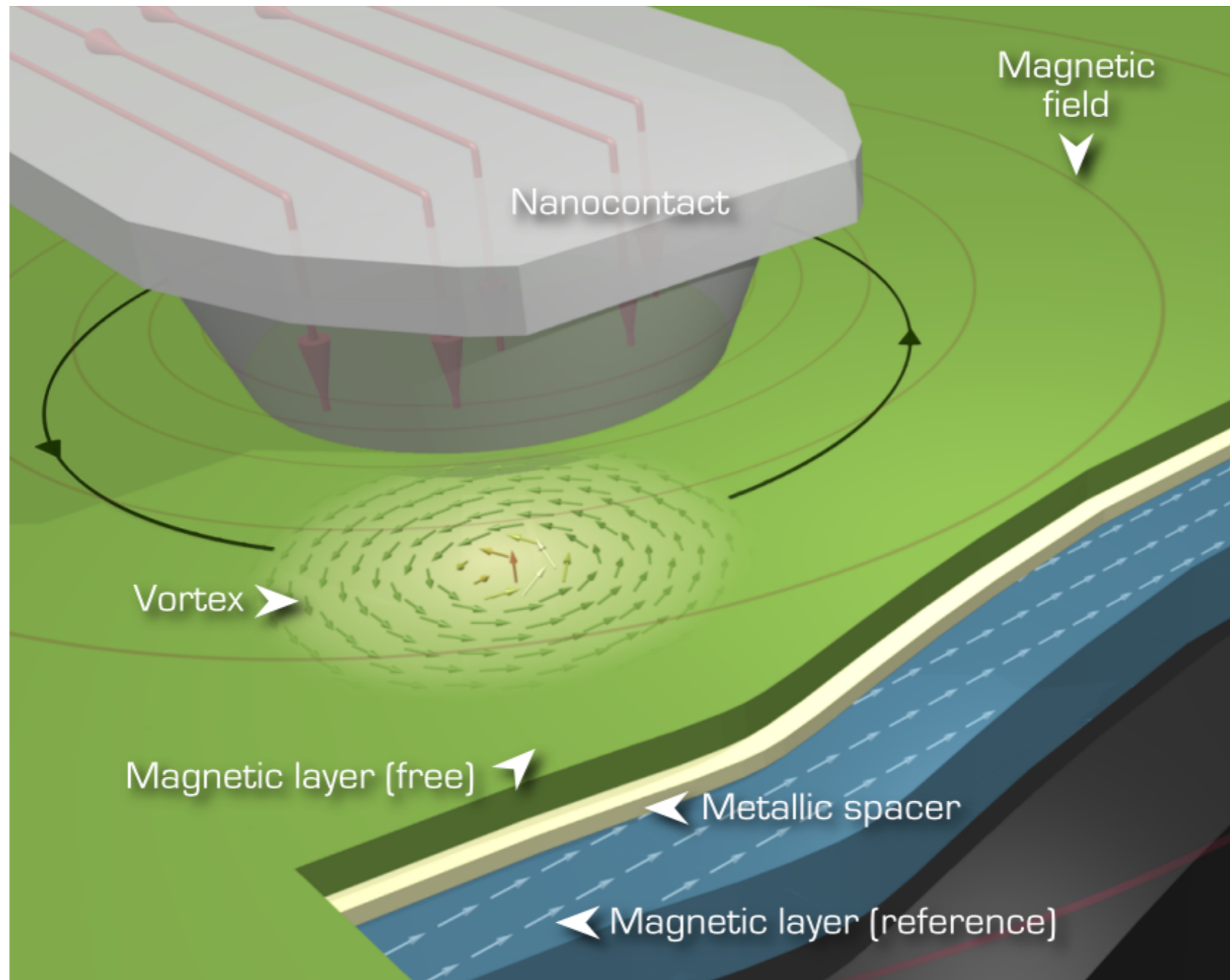
Arne Vansteenkiste

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Ben Van de Wiele

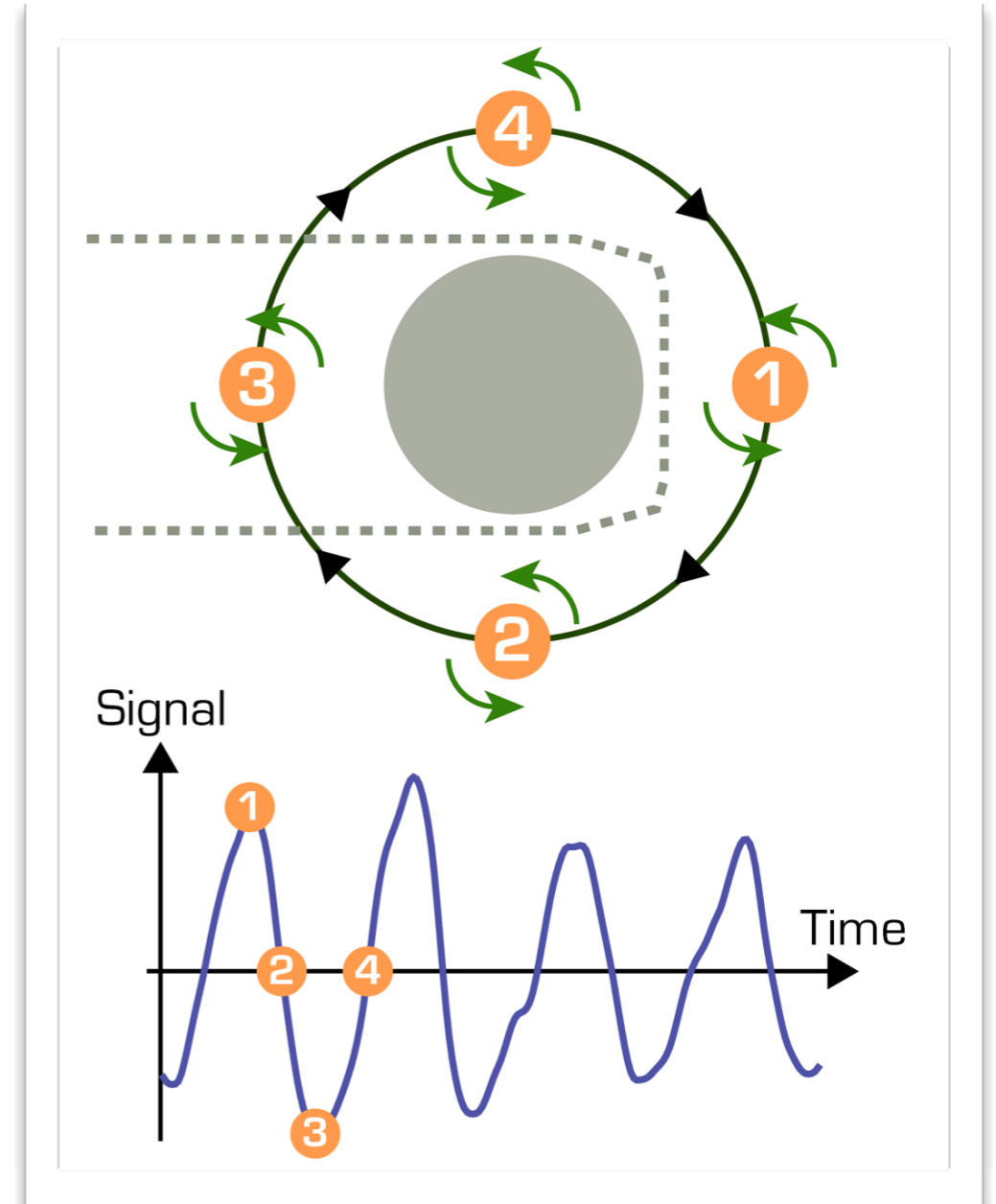
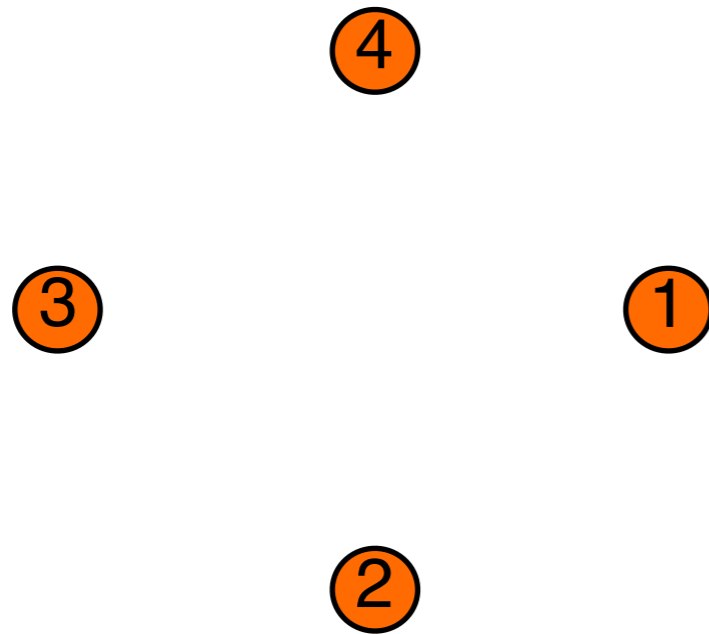
Department of Electrical Energy, Systems and Automation, Ghent University, Belgium

System: Nanocontact vortex oscillators



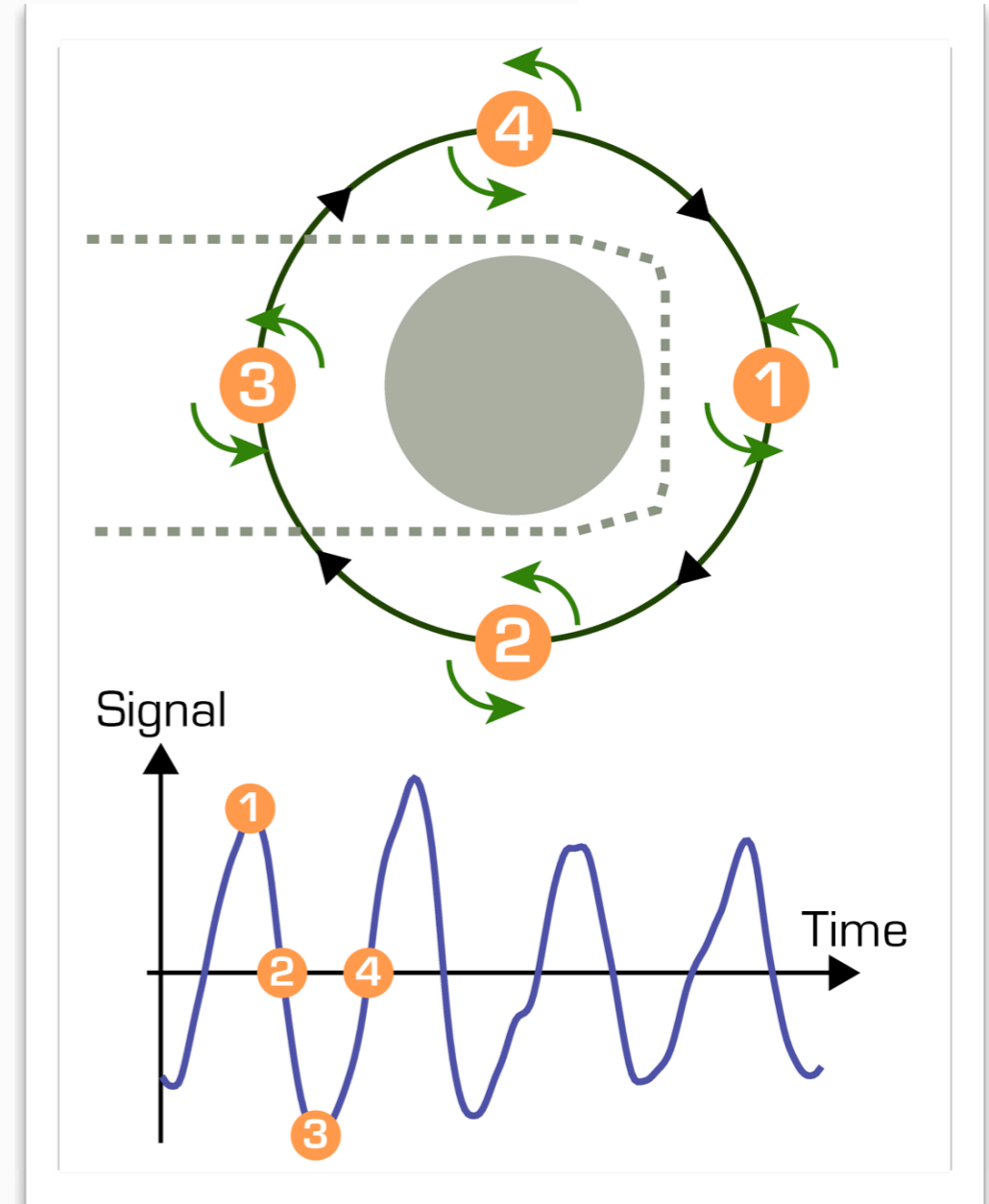
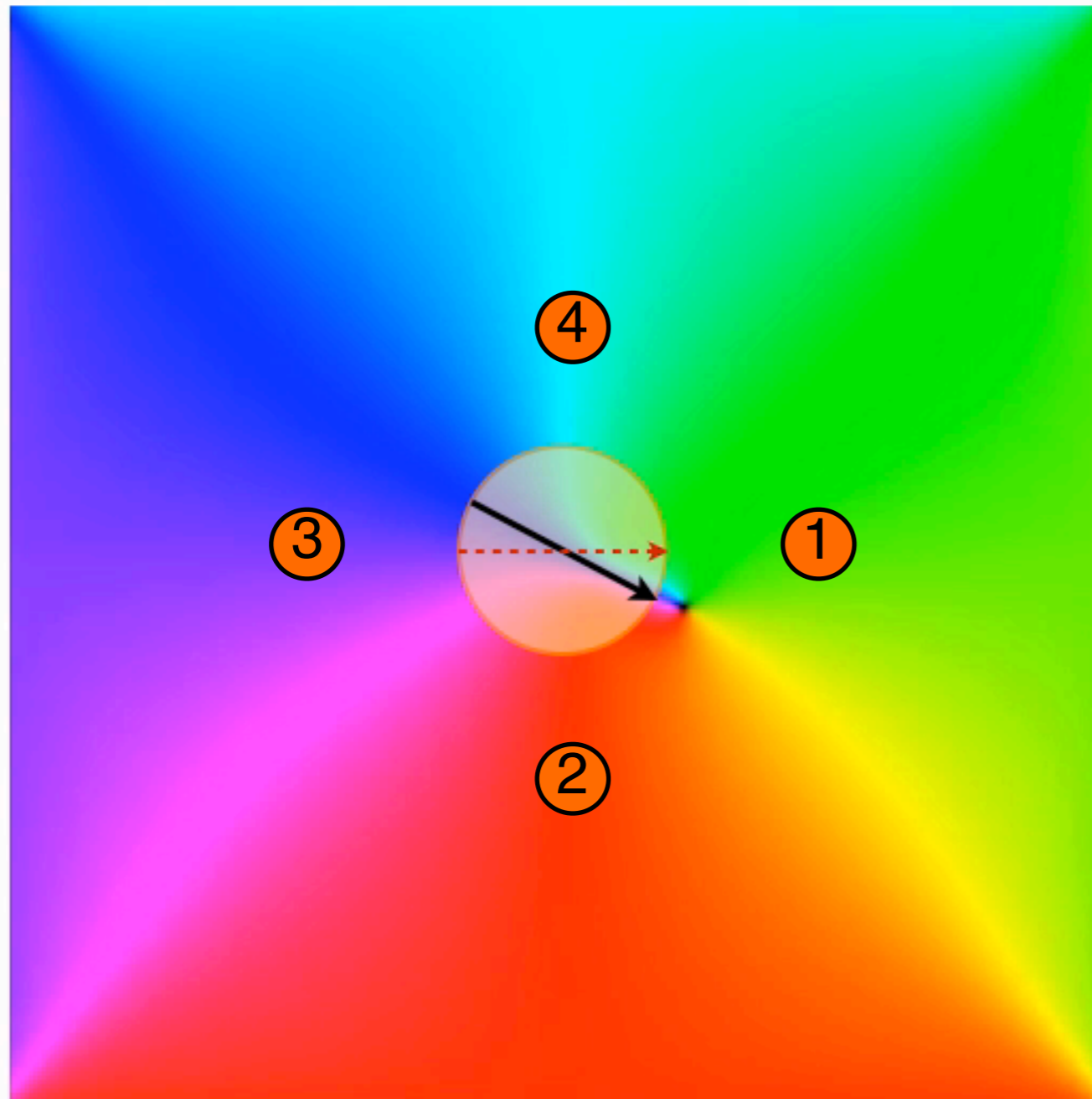
Composition: IrMn (6nm)/Co₉₀Fe₁₀(4.5nm)/Cu(3.5nm)/Ni₈₀Fe₂₀(5nm) NC: $\phi=120\text{nm}$

Detection of Vortex motion



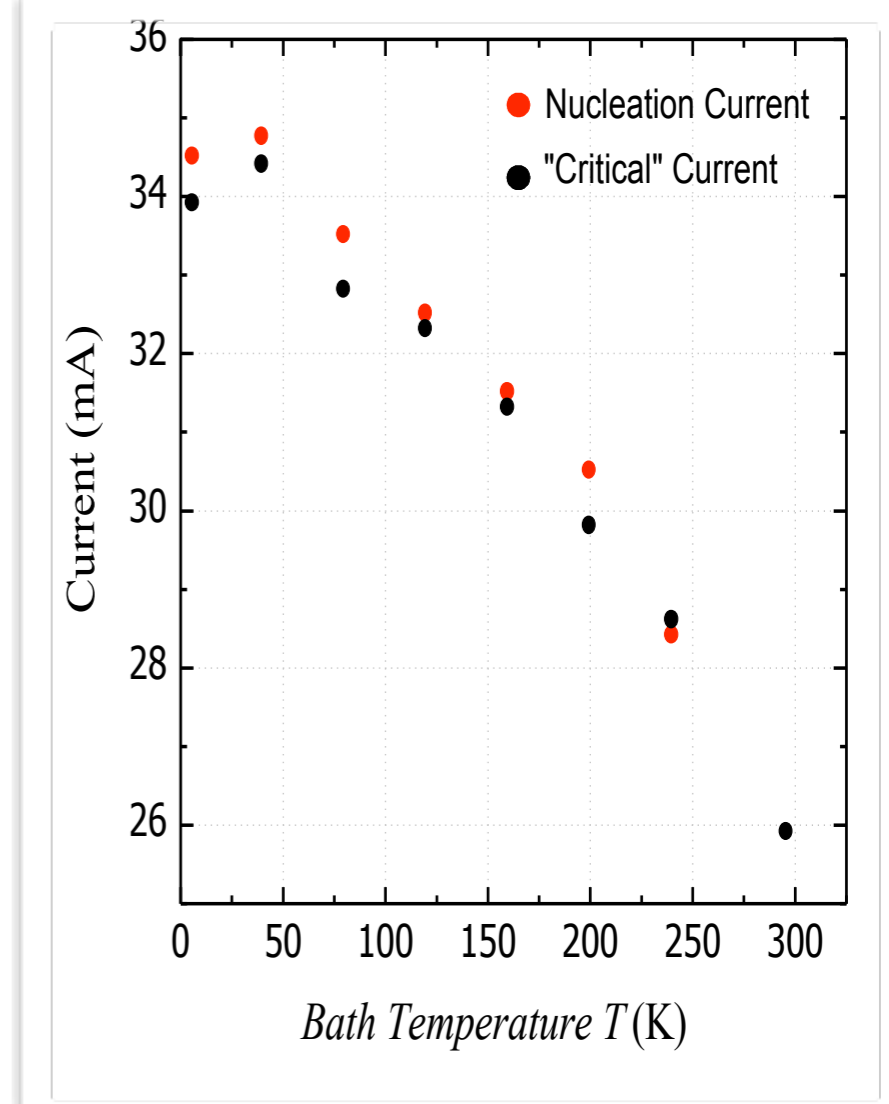
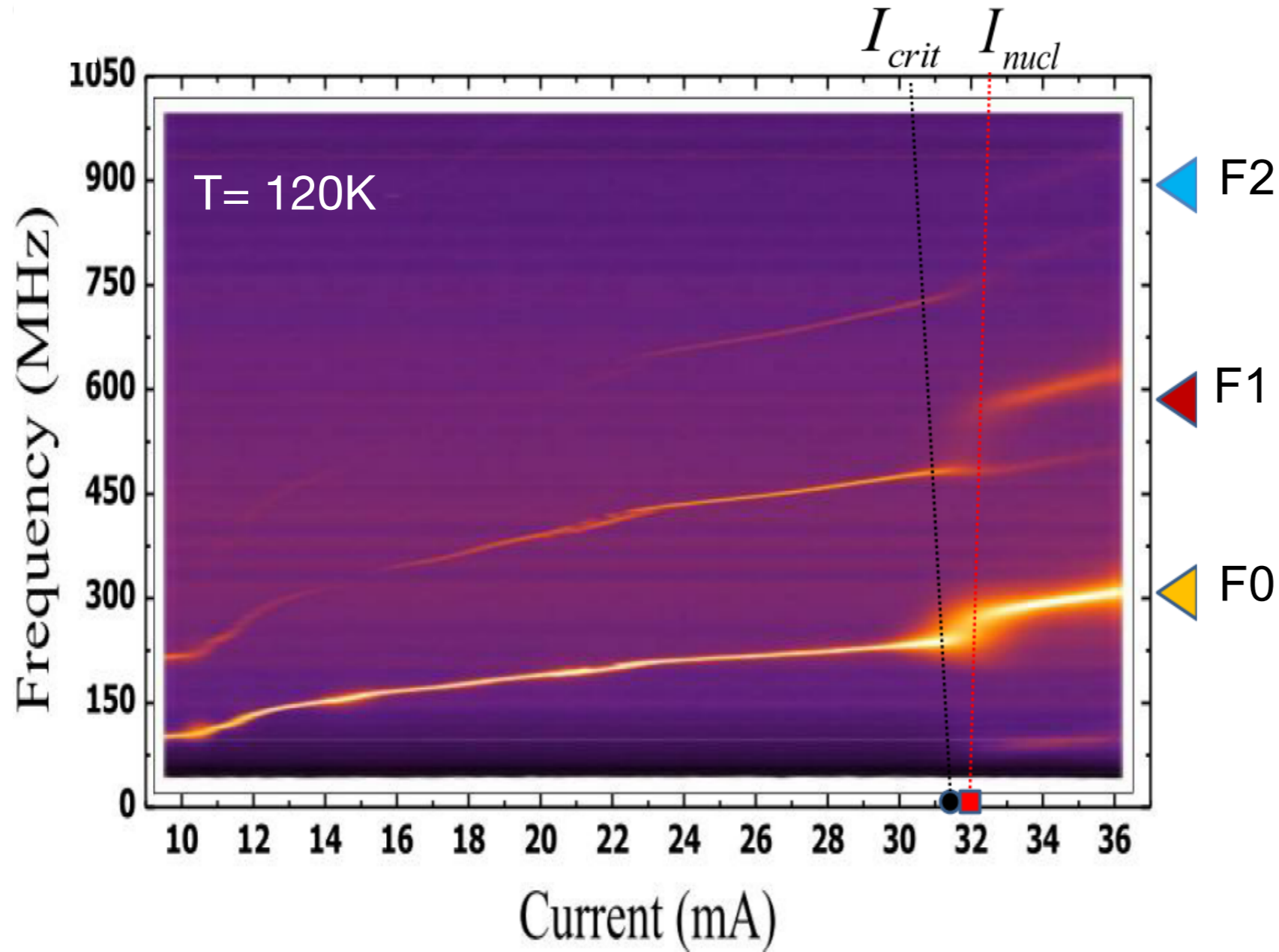
Simulations performed with **MuMax** code
Vansteenkiste & Van de Wiele, JMMM 2011

Detection of Vortex motion

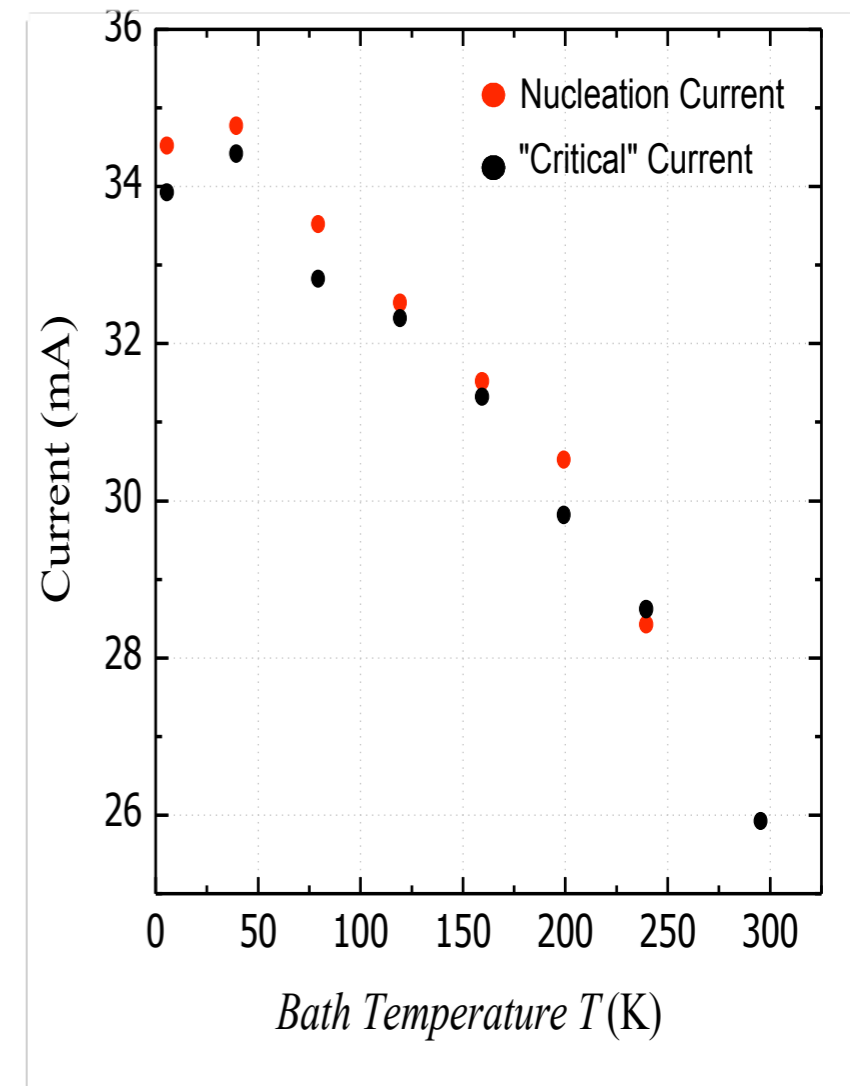
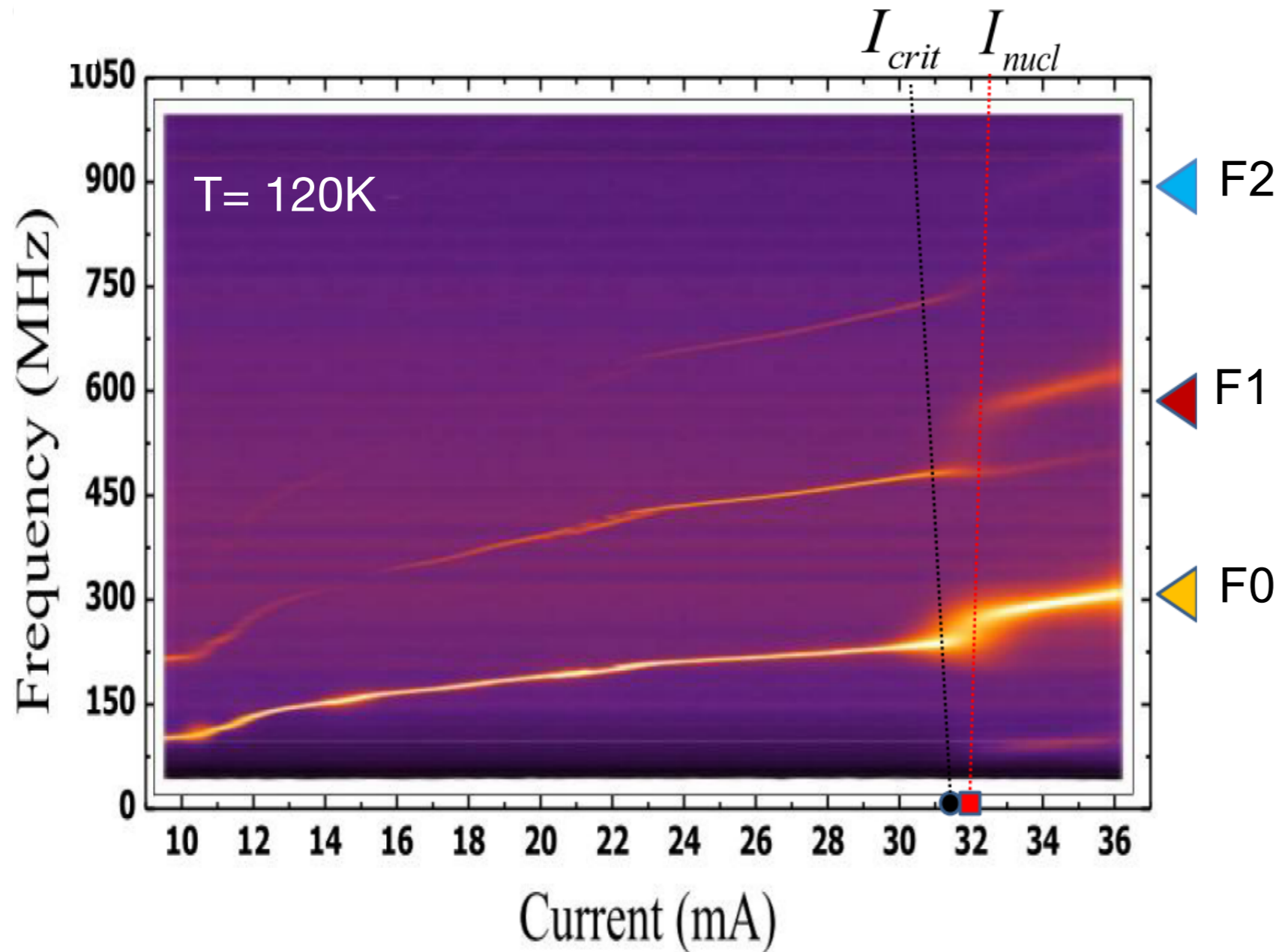


Simulations performed with **MuMax** code
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New oscillating behavior of the Vortex

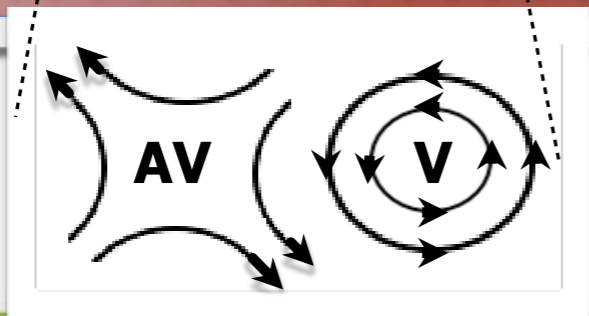
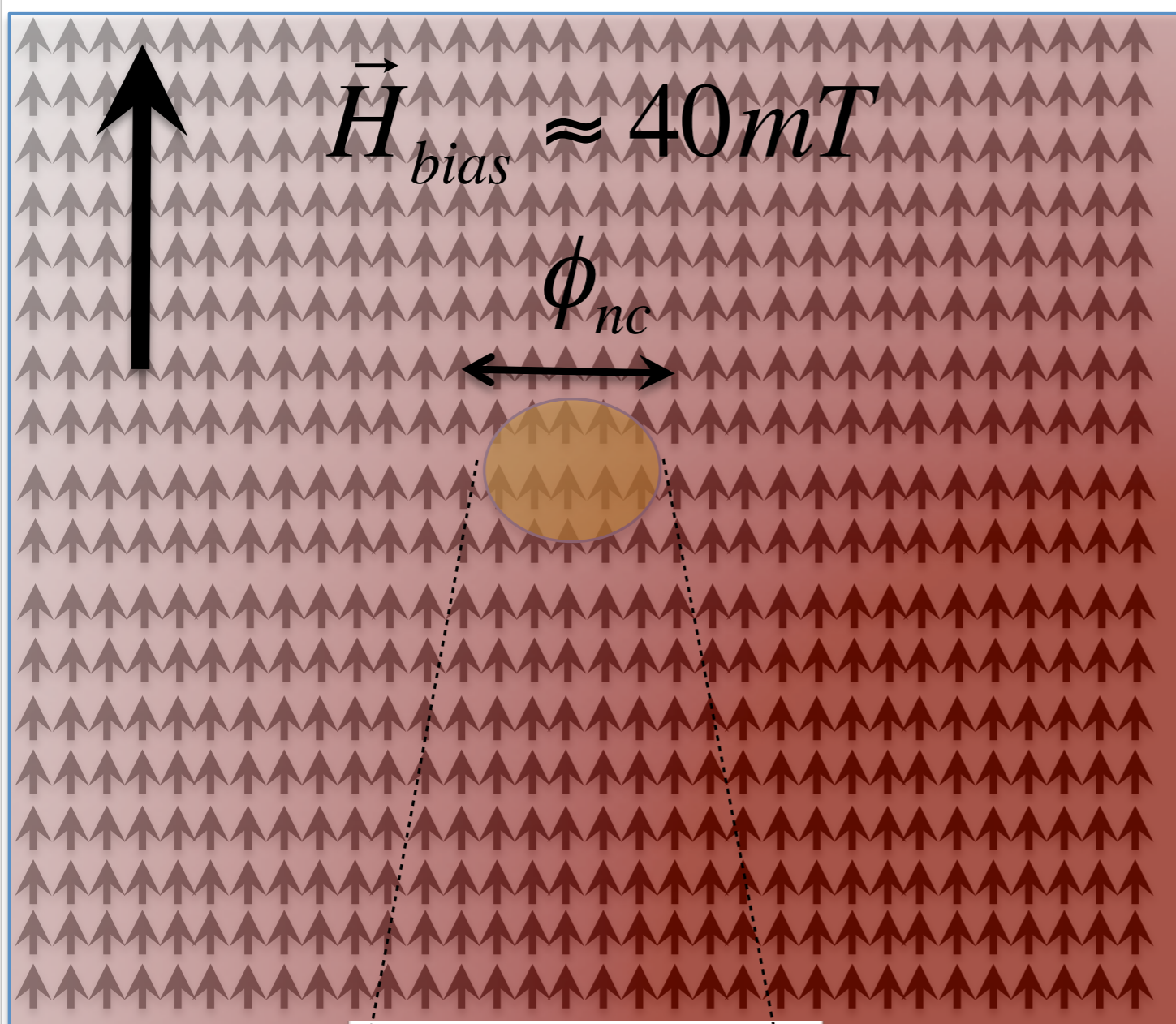


New oscillating behavior of the Vortex



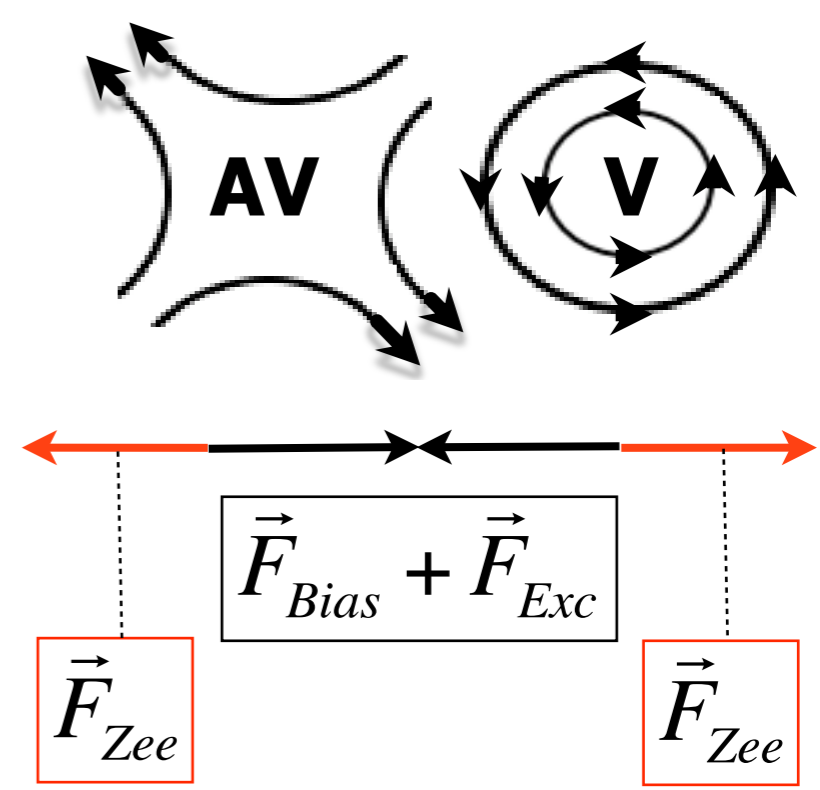
Can be this new trend explained by some nucleation in the pinned layer?

Nucleation in a "Pinned" layer

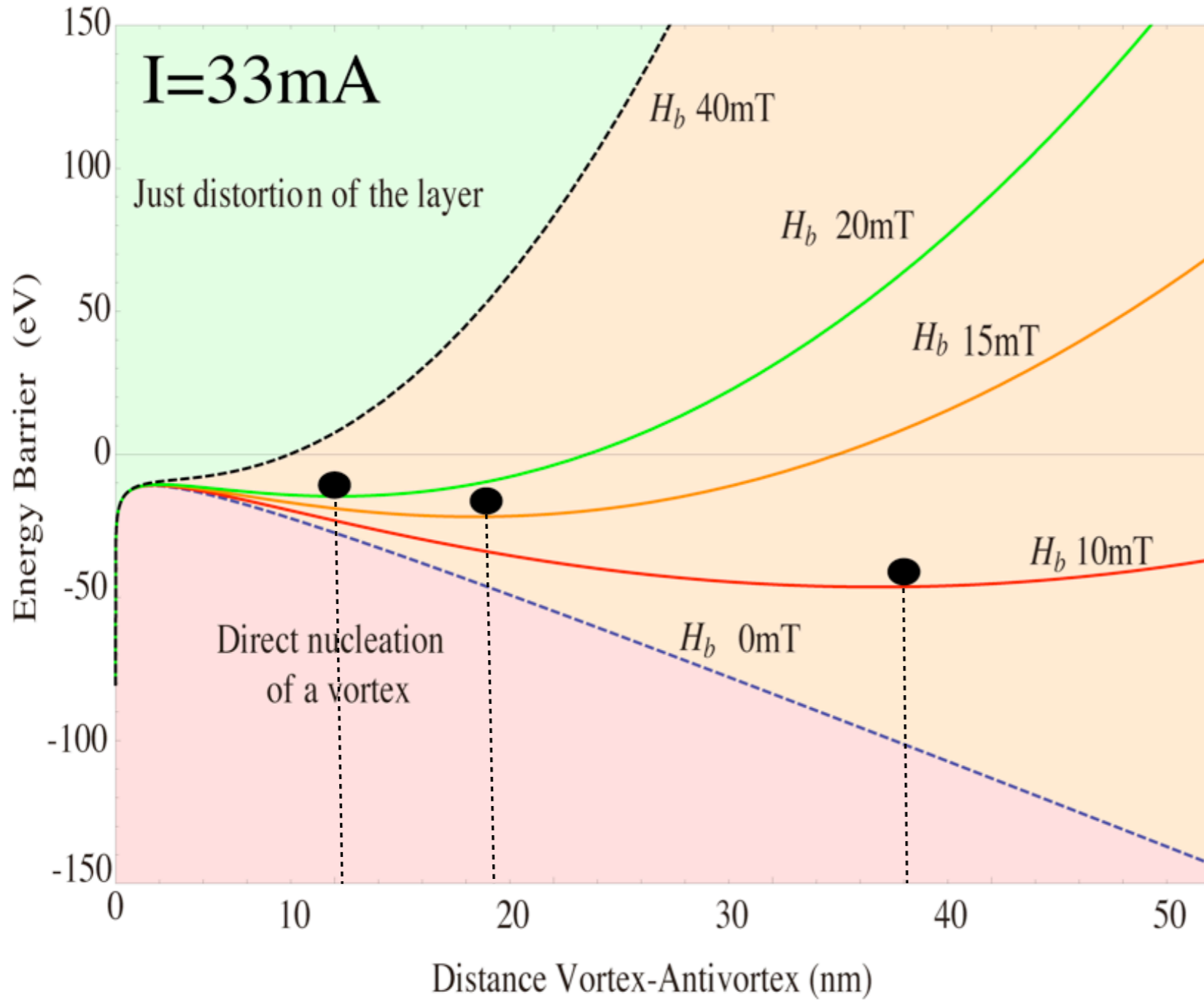


Nucleation means separation of the pair

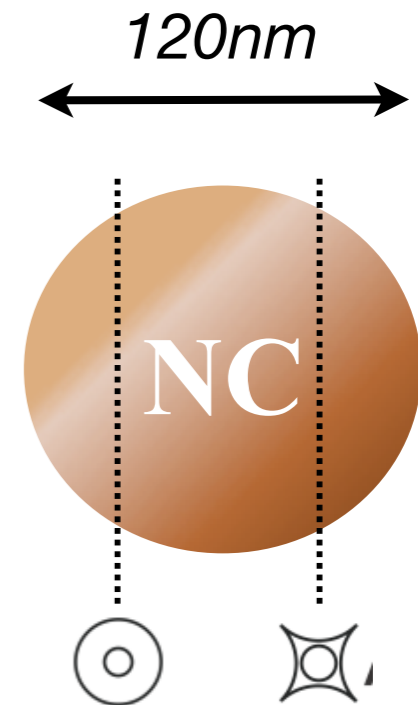
Competing forces:

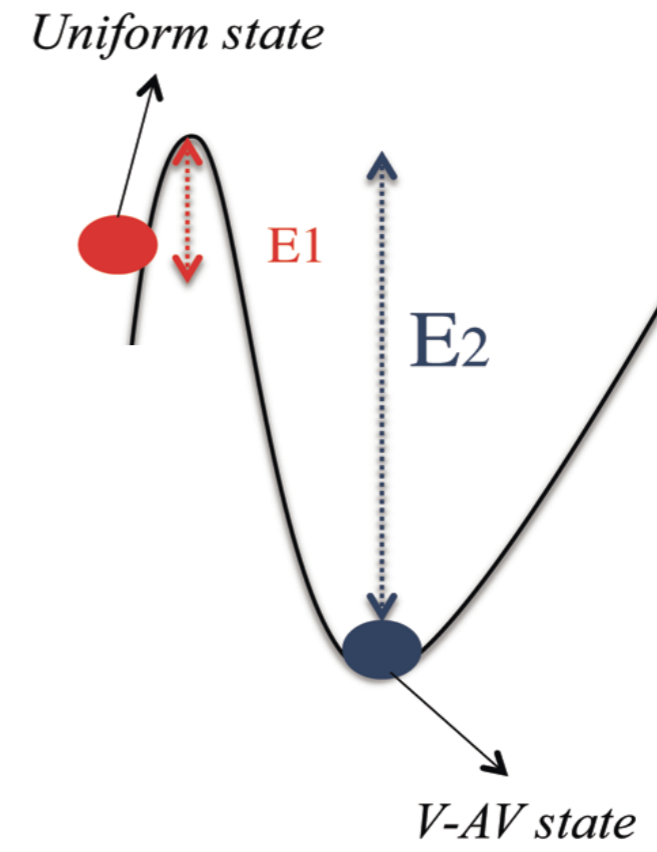
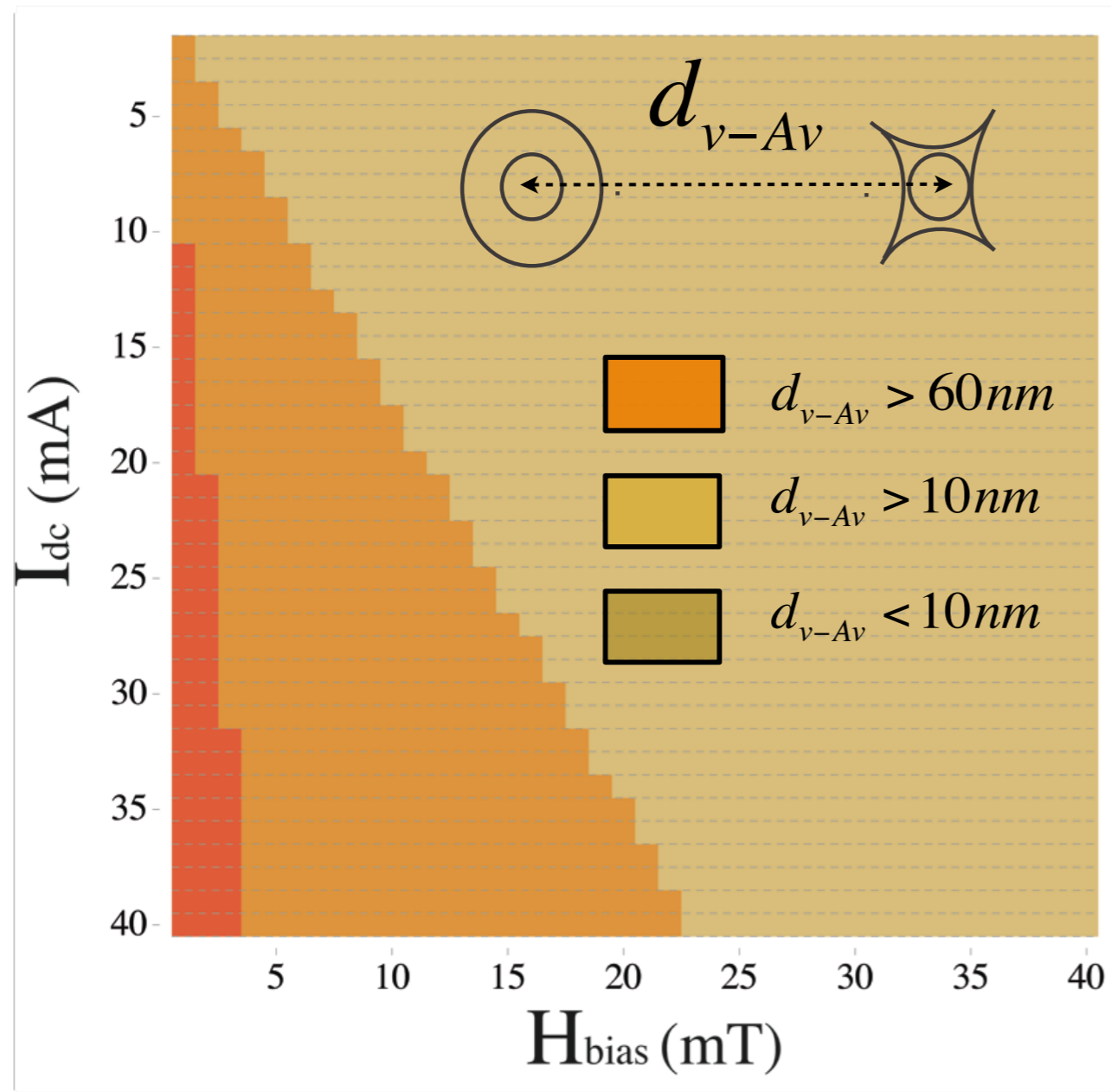


Energy terms versus distance V-AV

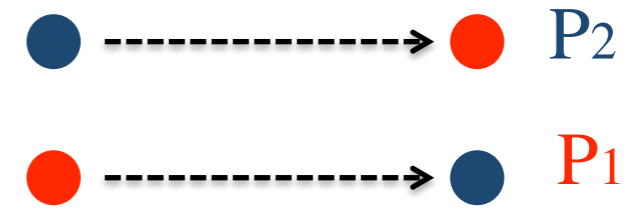


- “Stable” Vortex-Antivortex pair inside the nanocontact





Different probabilities to go from:

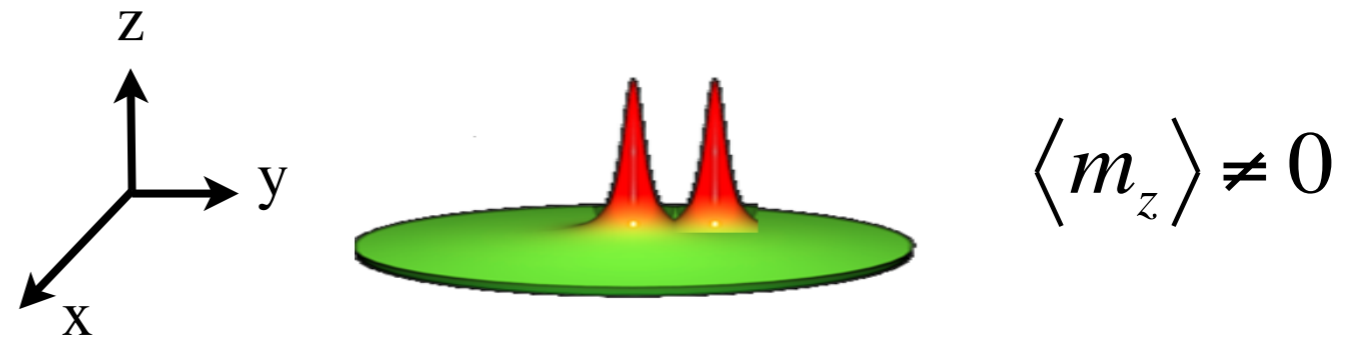
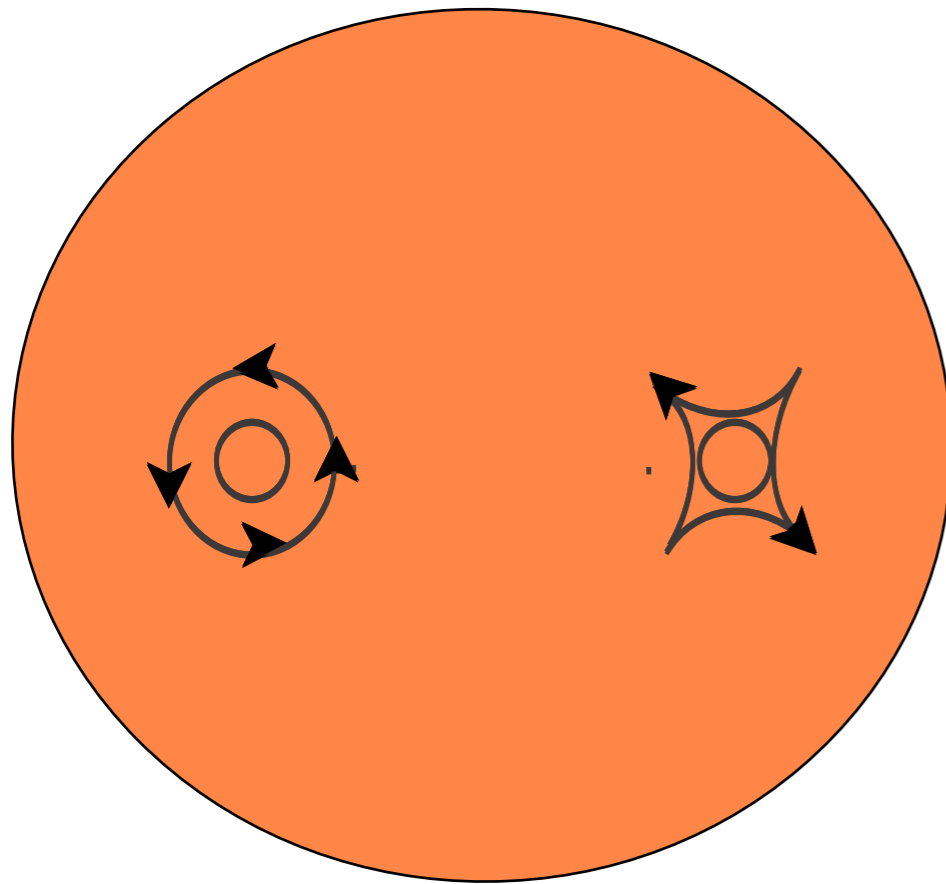


$$P_1 > P_2$$

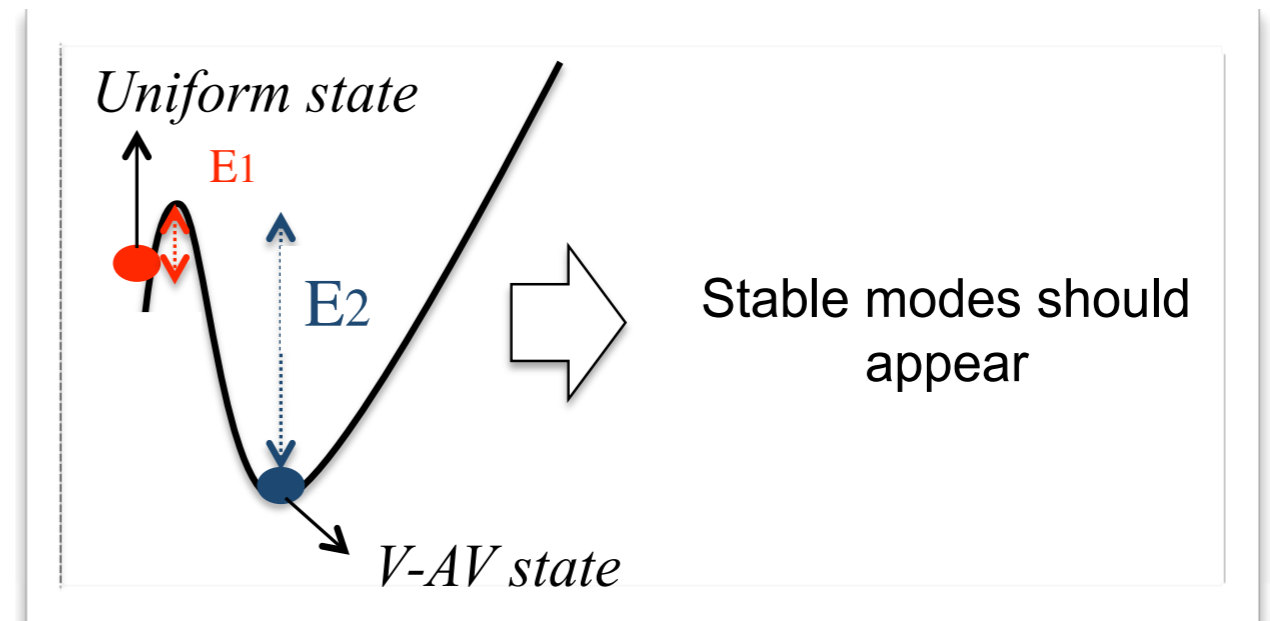
V-Av state is more stable
Annihilation is less probable

Consequence of the presence of the V-AV

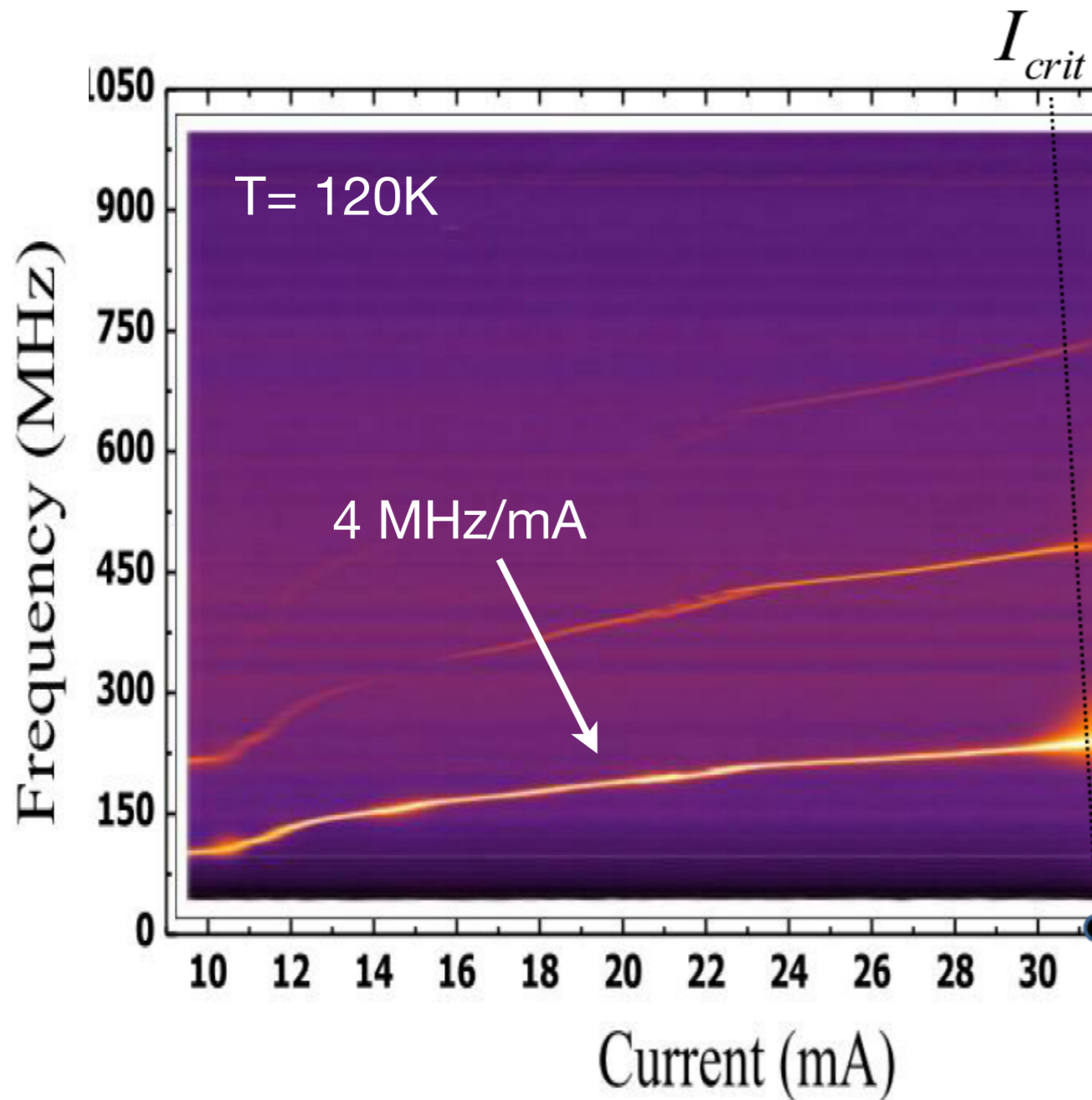
NC region
'Pinned' Layer



Influence in to the dynamics of the vortex in the free layer by perpendicular torque



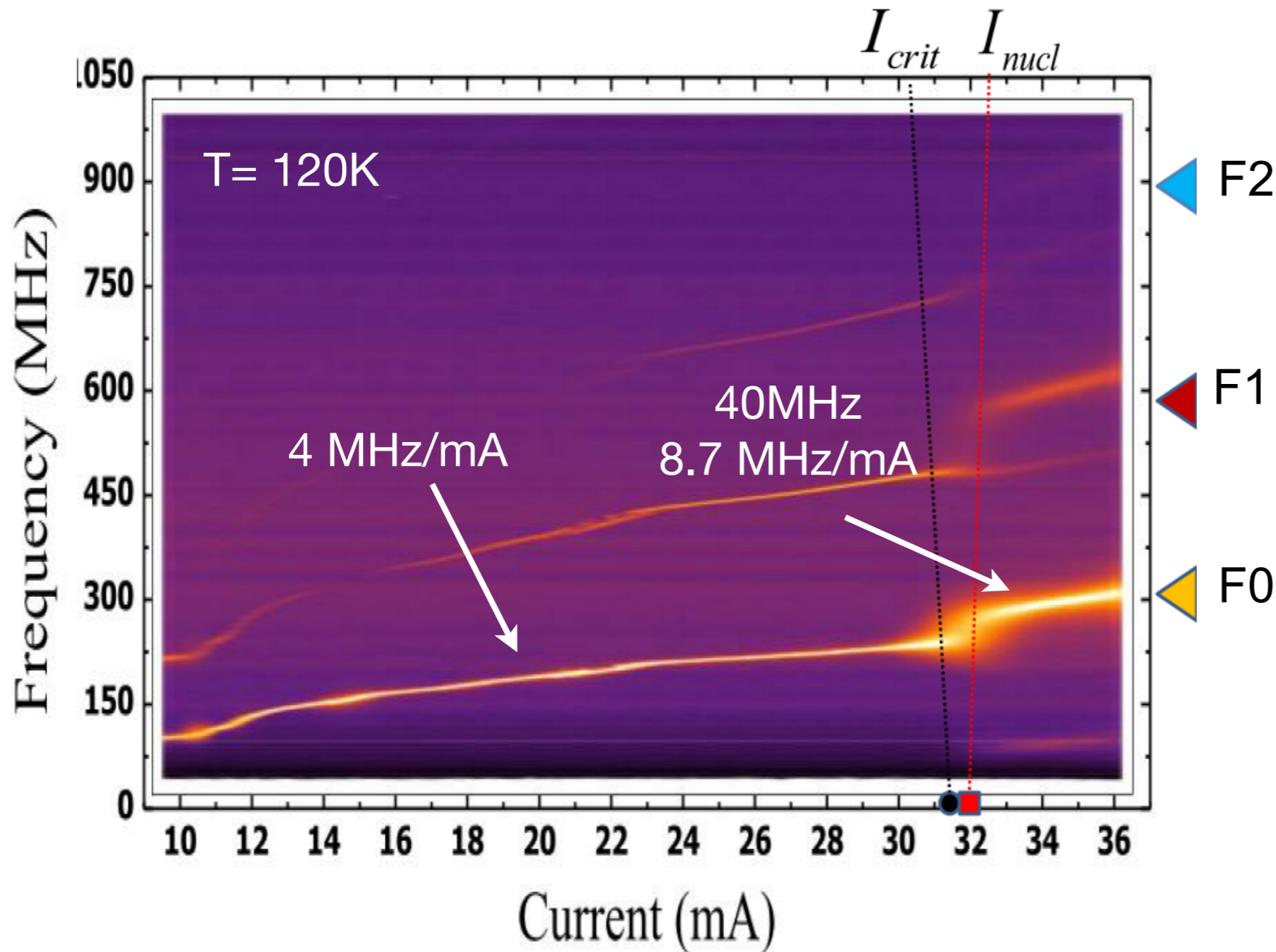
Comparison between Experiments & Theory



Rigid Vortex Model Approx.

Kim & Devolder, Arxiv:
1007.3859v1 (2010)

Comparison between Experiments & Theory



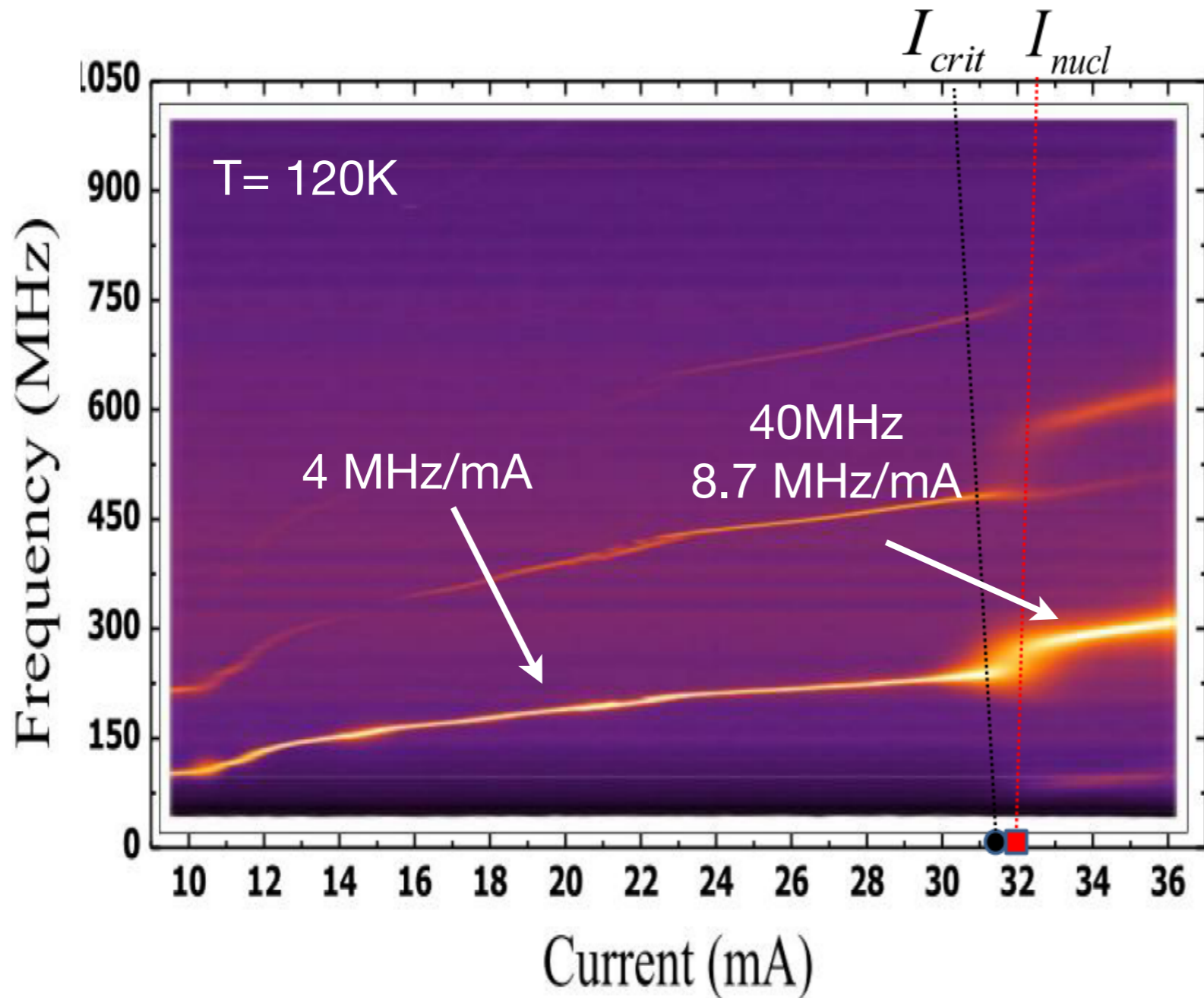
Rigid Vortex Model Approx.

Kim & Devolder, Arxiv:
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Integrating the presence
of the pair

Comparison between Experiments & Theory



Rigid Vortex Model Approx.

Kim & Devolder, Arxiv: 1007.3859v1 (2010)

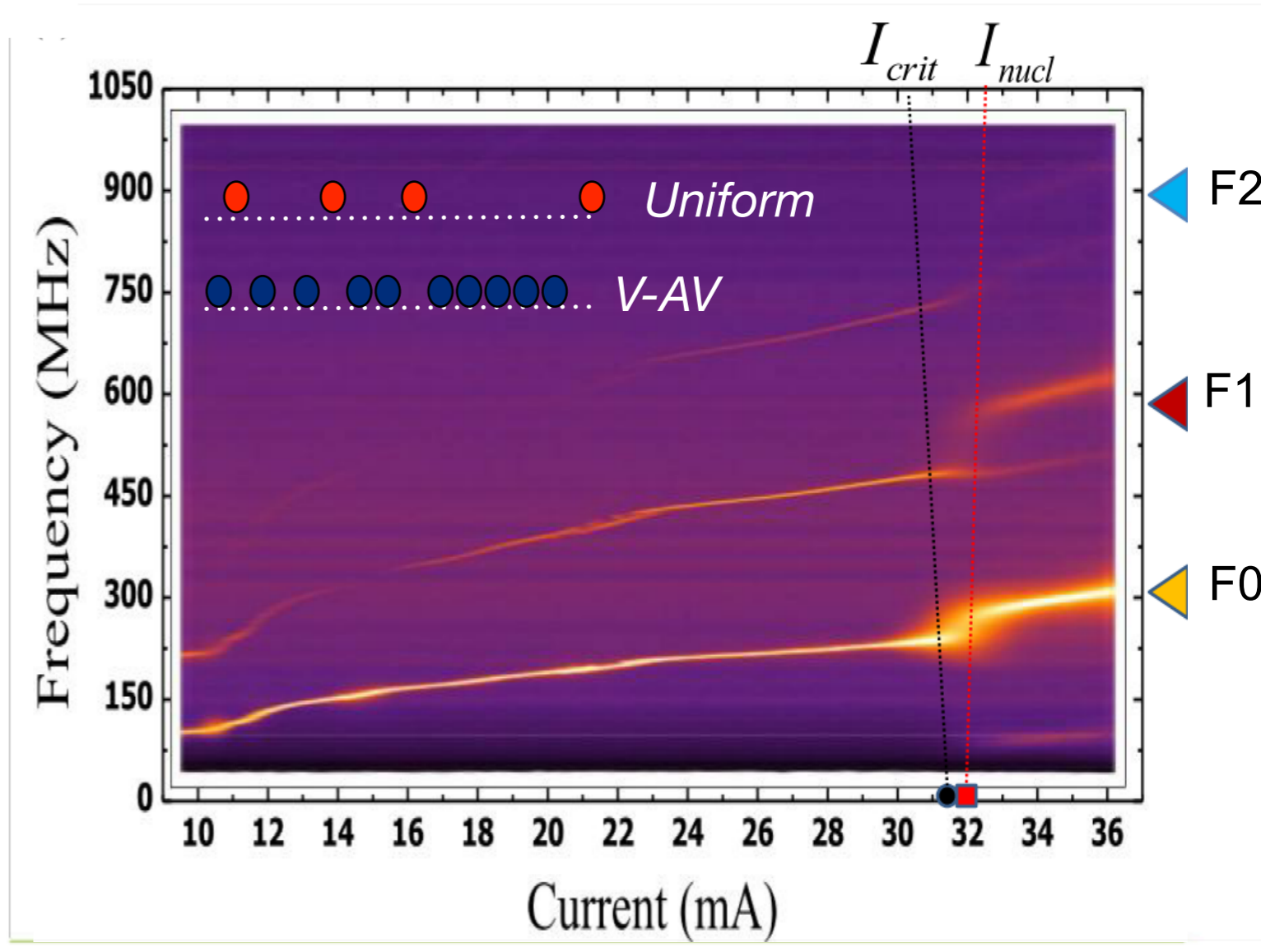
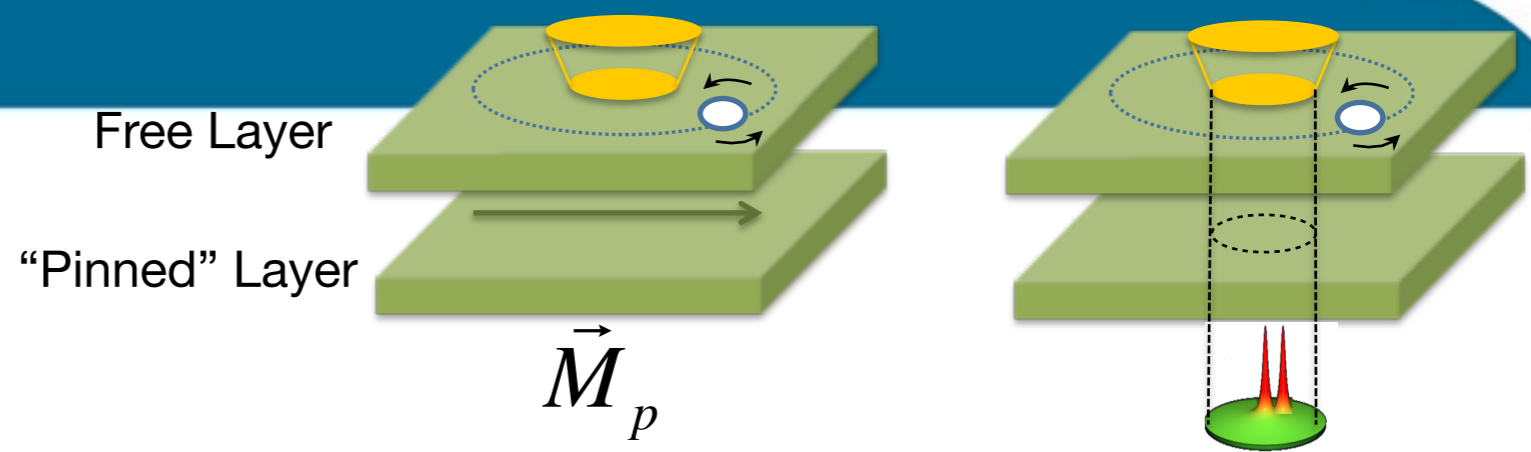
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Integrating the presence of the pair

Jump $\approx 15\text{MHz}$
Slope $\approx 7.8\text{MHz}$

Key Results & Perspectives

- New vortex dynamics at high current
- *Vortex hopping* between different modes (*Multiple Vortex-Antivortex nucleations & annihilations*)
- *Vortex-Antivortex generates new torque.*
- *Modulation effect?*



ACKNOWLEDGEMENTS



Dipolar interaction between V-AV and the Vortex

