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Thermoelastic damping in silicon and metallic discs: the mode-dependent branching effect

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For mechanical resonators in the acoustic band, thermo-elastic noise can be the dominant contribution to the thermal noise spectrum. Silicon membranes show a prominent thermoelastic peak below few kHz; silicon is widely used in precision applications and it represents a suitable solution for the test masses of future cryogenic GW detectors. We measured with GeNS the thermoelastic loss in a set of silicon disk samples, and found a dependancy of the loss angle upon the normal mode geometry. This behavior is deduced from the general theory in free disks but, to our knowledge, it was not yet shown in experiments. We also demonstrated that this feature is seen in homogeneous CuBe disks, proving that it is not related to the silicon anisotropy. We present the results of our measurements and a new theoretical approach exploiting the entropy increase; eventually, the mode-dependent loss is explained in terms of the ratio among dilatation energy and total elastic energy.

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