Negative thermal expansion of MgB$_2$ below $T_c$ – possible violation of the Ehrenfest relation.

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The thermal expansion of the near 40 K superconductor MgB$_2$ has been measured using a high-resolution thermal expansion cell constructed of fused quartz with sub-angstrom resolution. The thermal expansion coefficient changes from positive to negative upon cooling through the superconducting transition temperature $T_c$, thus, MgB$_2$ expands on cooling below $T_c$. The bulk Grüneisen parameter, which is proportional to $\gamma$, changes sign at $T_c$ as well. The jumps in $\gamma$ and the heat capacity at $T_c$ are used to estimate its pressure dependence, $dT_c/dP$; comparison to the measured value reveals violation of the Ehrenfest relation by 42%. The results suggest anomalous coupling between the lattice and superconducting electrons via low-energy phonons, and the discussion will highlight related behavior in A15 superconductors. Some recent results on small (0.1x0.5x0.5 mm$^3$) single crystals will also be presented.

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