The de Haas–van Alphen effect in the superconducting state of MgB$_2$. A. CARRINGTON, J. FLETCHER, H.H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, BS8 1TL, United Kingdom., S.M. KAZAKOV, J. KARPINSKI, Laboratorium für Festkörperphysik, ETH Zürich, CH-8093 Zürich, Switzerland. — The de Haas-van Alphen (dHvA) signal arising from orbits on the $\pi$ Fermi surface sheet of the two-gap superconductor MgB$_2$ has been observed in the vortex state below $H_{c2}$. An extra attenuation of the dHvA signal, beyond those effects described in the conventional Lifshitz-Kosevich expression, is seen due to the opening of the superconducting gap. Our data show that the $\pi$ band gap is still present up to $H_{c2}$. Using current theories of dHvA oscillations in the superconducting state we extract estimates for the evolution of the $\pi$ band gap with magnetic field. Contrary to results for other materials, we find that the most recent theories dramatically underestimate the damping in MgB$_2$. 

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