Unusual thermoelectric properties of BaFe$_2$As$_2$ in high magnetic fields

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Electric and thermoelectric transport properties are mutually intertwined in diffusive transport equations. In particular, in high mobility multi-band systems an anomalous behavior may occur, which can be tracked down to the properties of the individual bands. Here, we present magneto-electric and magneto-thermoelectric transport properties of a BaFe$_2$As$_2$ high quality single crystal, for different magnetic field directions (parallel and perpendicular to the c-axis of the crystal) up to 30 T. We detect an anomalous field dependence of the Seebeck coefficient (Fig. 1a and 1c) and a giant Nernst effect (Fig. 1b and 1d). The extraction of the Peltier tensor coefficients $\alpha_{xx}$, $\alpha_{xy}$ and $\alpha_{xz}$ (Fig. 2) allows to disentangle the main transport mechanisms into play. The large $\alpha_{xy}$ and $\alpha_{xz}$ values and their field dependence provide evidence of the presence of a high mobility band, compatible with a Dirac dispersion band, crossing the Fermi level and suggest a possible 3-dimensional nature of the Dirac Fermions.

Fig. 1: Magnetic field dependences up to 30 T in the temperature range 5-80K of the Seebeck/Nernst coefficient when B is applied parallel (a/b) and perpendicular (c/d) to the c-axis of the crystal.

Fig. 2: Magnetic field dependences up to 30 T in the temperature range 5-80K of $\alpha_{xy}$. Dashed lines are the fitting curves of $\alpha_{xy}$ using $\alpha_{xy} = A\mu^2B/(1 + (\mu B)^2)$, where $\mu$ is the carrier mobility. Inset: temperature dependence of $\mu$ obtained by the fitting.