Search for new high $T_c$ superconducting oxides

**General Scope:**
Unconventional superconductivity with high critical temperature ($T_c$) occurs by doping two-dimensional (2D) compounds presenting an antiferromagnetic order with a high Néel temperature ($T_N$) and a moderate magnetic moment. This is linked to the strong exchange interaction, responsible for antiferromagnetism but also for superconductivity. This is the case for cuprates and iron-based chalcogenides or arsenides. Thus a reasonable strategy to find new superconductors, based on a spin fluctuations mechanism, is to select materials with these properties, synthesize them and chemically dope them. In particular chromium compounds are known to have strong antiferromagnetism. These low dimensionality oxides are difficult to synthesize, which is an important obstacle, but also allows us to be among the first to study them recently and to understand their physics. This can be very rich, regardless of whether or not superconductivity is obtained (Kondo Orbital effect in CrSe$_2$ [M. Núñez et al. Phys. Rev. B. 88 (2013)]; Quantum fluctuations at 600 K in CrRe [D. Freitas et al. Phys. Rev. B. 92 (2015)])). Even if few years ago, thinking about finding superconductivity in chromium compounds made experts sceptical, its discovery in CrAs under pressure [Wu Wei et al. Nature Comm. 5 (2014)], now allows to expand this type of study.

**Research topic and facilities available:**
We propose to perform the doping of the Ruddlesden-Popper $\bar{AE}_{n+1}Cr_nO_{3n+1}$ series (where $\bar{A}$E is an alkaline earth, see figure) by adequate chemical substitution. We have already synthesized the parent phases $n = 1$, 2 and 3, and we have understood their physics, thanks to a collaborative work between experimentalists and theoreticians [Jeanneau et al. PRL 118 (2017)]. The synthesis of these oxides requires high pressure and high temperature conditions, which are available in the high-performance infrastructure of Institut Néel. The crystallographic, electrical and magnetic properties, as well as the specific heat and the thermal expansion of the doped samples will be probed thanks to the various experimental setups available in our laboratory. Measurements under very high pressure, in particular transport measurements, will complete the study.

**Possible collaboration and networking:**
Measurements using neutron scattering (ILL) and/or X-rays on synchrotron (ESRF) will also be required in the medium term to understand the full set of properties. On the other hand, this subject will benefit from interactions with the theoreticians of the laboratory or from abroad.

**Possible extension as a PhD:** Yes (via a selection organized by the Physics Graduate School).

**Required skills:** A good knowledge of the physics of condensed matter is desired.

**Starting date:** April 2019.

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