

# TERAPOL

## TERahertz Axion POLaritons

C. Braggio

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## OBJECTIVE

Investigate AF-TIs materials (e.g.  $\text{Mn}_x\text{Bi}_y\text{Te}_z$ ) which might host axion quasiparticles by means of a **terahertz time domain spectroscopy apparatus (THz-TDS)**

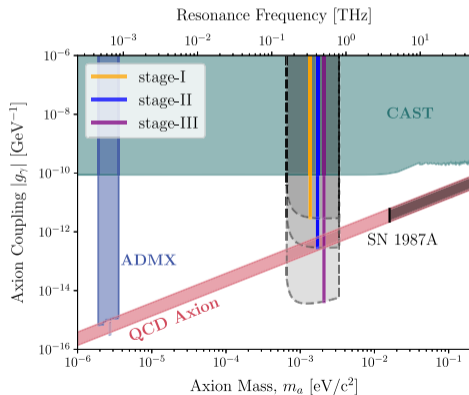
PHYSICAL REVIEW LETTERS **123**, 121601 (2019)

### Proposal to Detect Dark Matter using Axionic Topological Antiferromagnets

David J.E. Marsh<sup>1,\*</sup>, Kin Chung Fong<sup>2</sup>, Erik W. Lentz<sup>1</sup>, Libor Šmejkal<sup>3,4,5</sup> and Mazhar N. Ali<sup>6</sup>

F-TIs materials can host quasiparticles which are resonantly driven in the presence of axions and emit THz photons which can be detected using a single photon detector

- $0.7 < m_a < 3.5$  meV, axion mass interval currently inaccessible to other DM experiments or proposals
- $V_s \lesssim 1 \text{ cm}^3$  (stage I);  $\times 100$  (stage II)
- tunability of the resonance with applied magnetic field



## TERAHERTZ TIME DOMAIN SPECTROSCOPY (1)

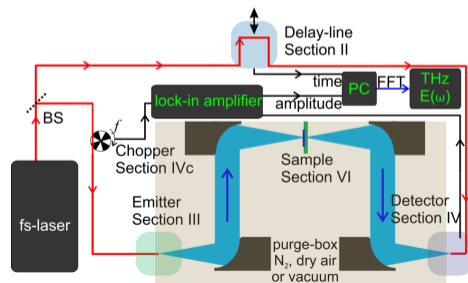
### Spectral range 0.1 – 1 THz

→ region of interest for vibrational spectroscopy of liquids, low frequency modes of molecular crystals, drugs, explosives...

→ suited to measure the dynamics of **mobile charge carriers** since they reflect and absorb terahertz radiation

*in 2012 we tested high speed semiconductors within the INFN MIR experiment (gr2)*

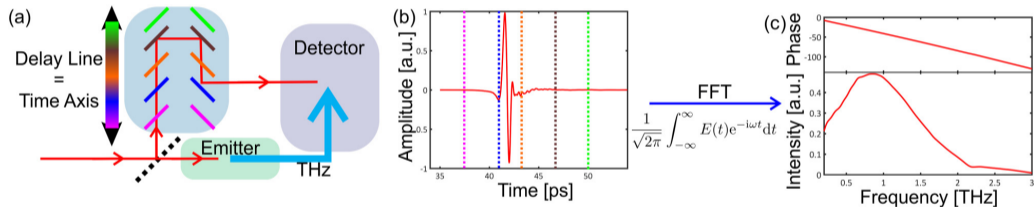
- femtosecond laser (mode-locked Ti:Sa)
- two beam paths, one with delay
- photoconductive antennas
- lock-in techniques



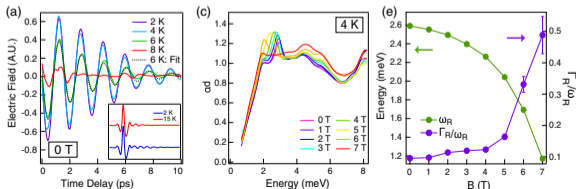
## TERAHERTZ TIME DOMAIN SPECTROSCOPY (2)

Observables: in the transmission spectrum we search for a **resonance** whose frequency and width coincide with the relevant polariton parameters necessary to use AF-TIs as axion dark matter detectors.

How **time domain** measurements can provide **spectral information**:



The measurement will be performed at a series of **cryogenic temperatures** and **large magnetic fields** Es.  $\alpha$ -RuCl<sub>3</sub>



## TERAPOL (TERAHERTZ AXION POLARITON)

- Sezioni: **Padova, Pavia**
- Responsabile Nazionale: C. Braggio
- Partecipazione FTE PD:  
F. Borghesani (50%), C Braggio (50%), L. Dell'Anna (40%), + E. Conti (10%)...
- Richieste finanziarie 30 keu (2021), 20 keu (2022)
- Richieste sezione: 2 MU O.M., 3 MU O.E.