Reports on topological phases and harmonic generation: circular polarized laser field driver

September 21, 2019

Topological dependence of high-order harmonic generation

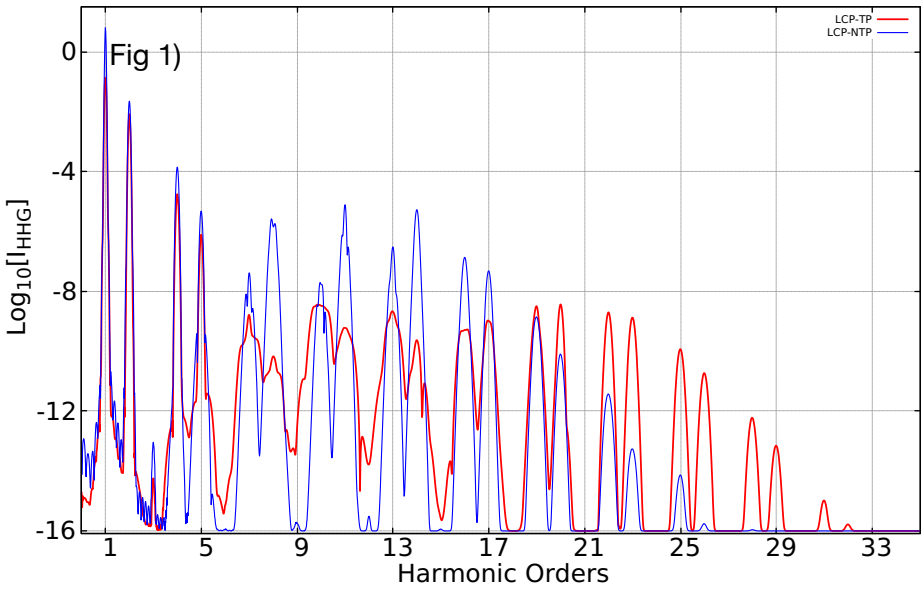


Fig. 1) Blue line (topological non-trivial phase) and red line (topological trivial phase) depict the high-order harmonic generation (HHG) for two different topological phases of Haldane model (HM) while a left-handed circularly polarized (LCP) driven laser of field strength E0 = 0.005 a.u. and the photon energy is w0 = 0.015 a.u. drives the crystalline Haldane lattice. The dephasing time was fixed to T2 = 220 a.u. and the band gap for both topological phase are equals, Eg = 0.112 a.u. The Haldane model parameters are \phi0 = 0.06 rad for trivial phase, \phi0 = 1.16 rad for the topological phase, while M0/t2 = 2.54 keep constants.

For this numerical results, we can appreciate a huge enhancement of the topological harmonic orders for the topological phase (C=+1, Chern No.) around the cut-off than those HOs corresponded to the trivial phase (C=0, Chern No.)

Circular Dichroism for trivial and non trivial phase

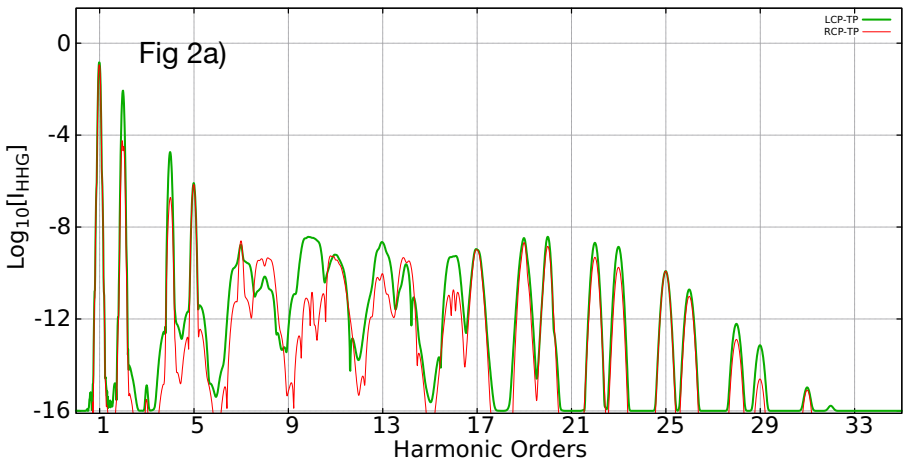
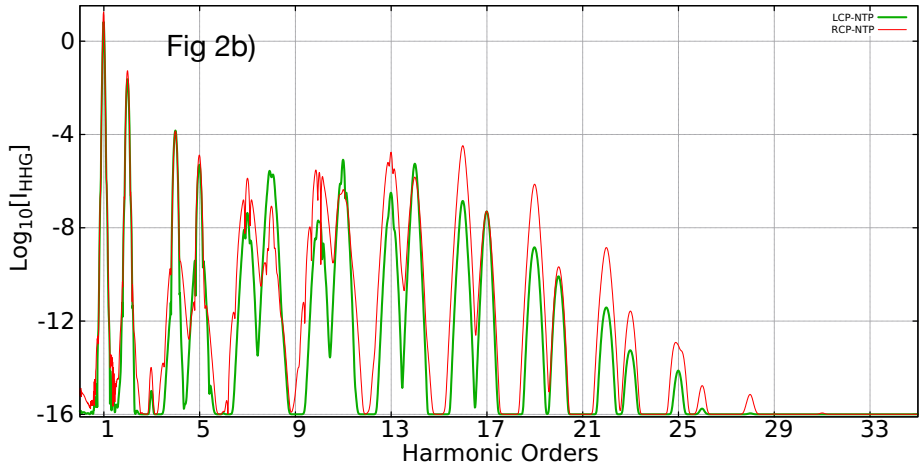


Fig 2a) This figure shows the HHG spectra for LCP and Right-handled and circularly polarized (RCP) in green and red, respectively for similar parameters



of the trivial phase used in Fig 1) .

The HHG spectrum shows a remarkable **negative dichroism** for the plateau and cut-off around the 3n+1, but positive in the cut-off for 3n+2.
Fig 2b) In green and red lines, we have the HHG spectra for LCP and RCP within a topological phase where phi0 = 1.16 rad. Laser field parameters used here are the same than those used in Fig 1) and the dephasing time too, T2 =220 a.u.

Topological phase transition using circular Dichroism (CD)

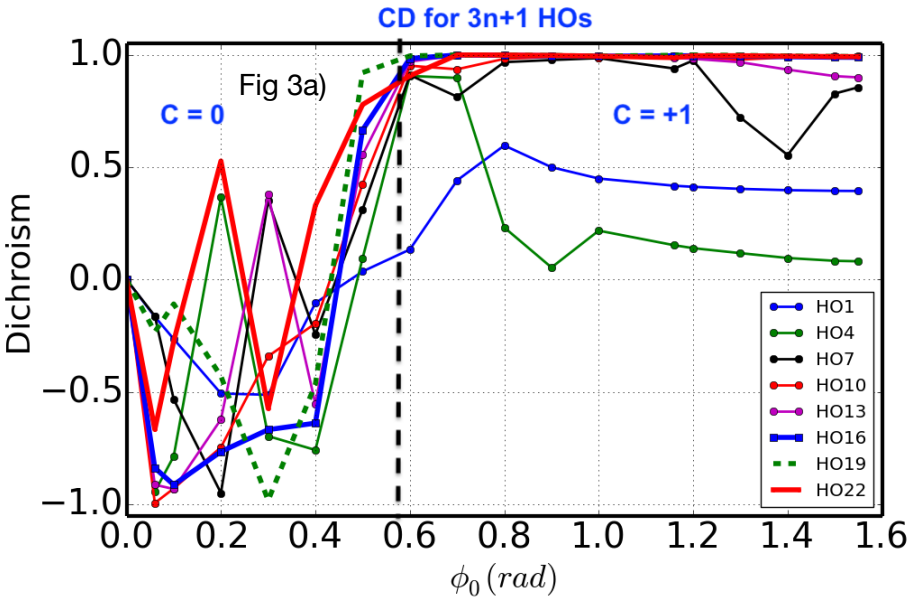


Fig 3a) Depicts the circular dichroism (CD) as a **function of the MAGNETIC FLUX PHASE, phi0,** and M0/t2 = 2.54 of Haldane Model for every harmonic order corresponding to 3n + 1. The laser pulse is a large pulse of 36 cycles under a cos^2 envelope and with a laser field strength of E0=0.0045 a.u.

The Chern number for values \phi0 < 0.51 rad is zero (fully trivial phase), with respect to the black dashed vertical line approximately speaking. Chern No. is +1 for \phi0 > 0.51 (fully topological non-trivial phase).

First of all, one can notice from Fig3a), there is a potential to distinguish trivial phase from non-trivial phase by the CD, since CD is mostly negative for trivial phase while CD is positive for non-trivial phase in average for most of the 3n+1 HOs.

Secondly, for the trivial phase, the CD is fluctuating between positive an negative values. This is attributed mainly to time dephasing effects as the Fig. 4 will show.

Fig 3b)

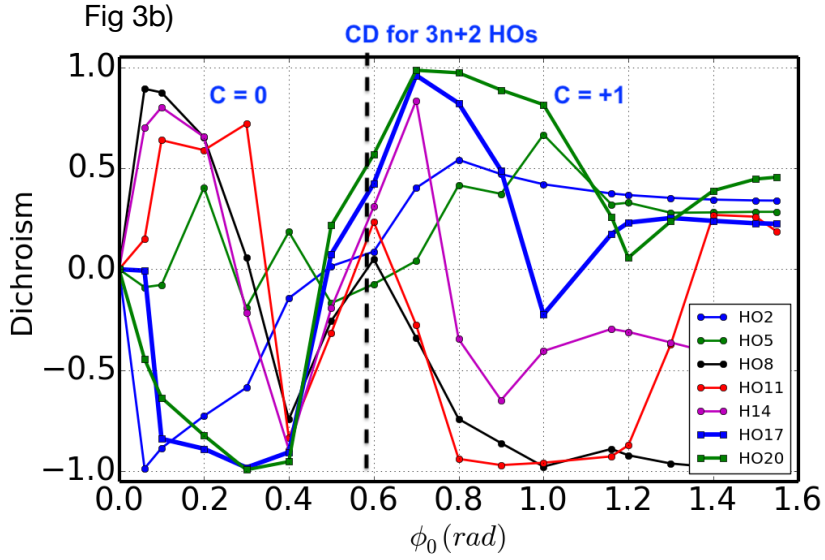


Fig 3b) CD as a function of the magnetic flux phase, phi0, corresponding to each HOs 3n+2.
The CD of this 3n+2 harmonics are not really clear quantity to distinguish one topological phase from other.

This plot CD in 3b) is in contrast to what it is observed in 3a). There is a set of possible reasons or, 1) dephasing time, 2) nature of the breaking symmetries, Time-reversal symmetry and space-inversion symmetry sensitivity of those 3n+2 Harmonic orders. Perhaps, there exist another couple of reason why we have this chaotic behaviors on the HHG HOs, but so far, this two I suspect are the most reasonable one. however, I dont know.

Dephasing Study

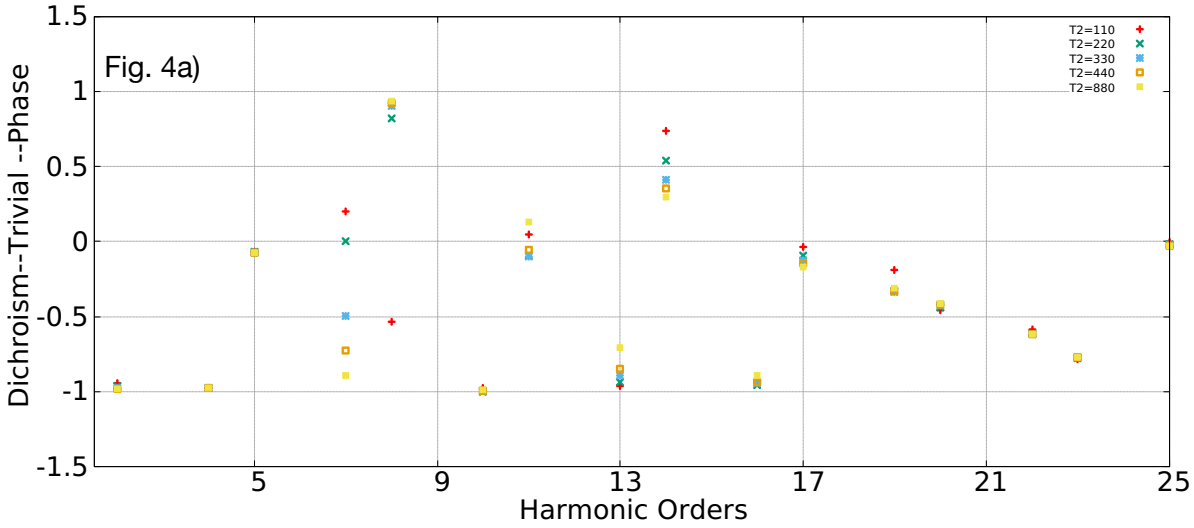


Fig 4a) Shows the CD of HHG spectrum for a trivial phase of Haldane model with M0/t2 = 2.54 and phi0= 0.06 rad for each HO as a function of the dephasing time T2. The CD for HOs>5th is **EXTREMELY SENSITIVE** to the choice of the Dephasing time in particular around the plateau and cut-off.

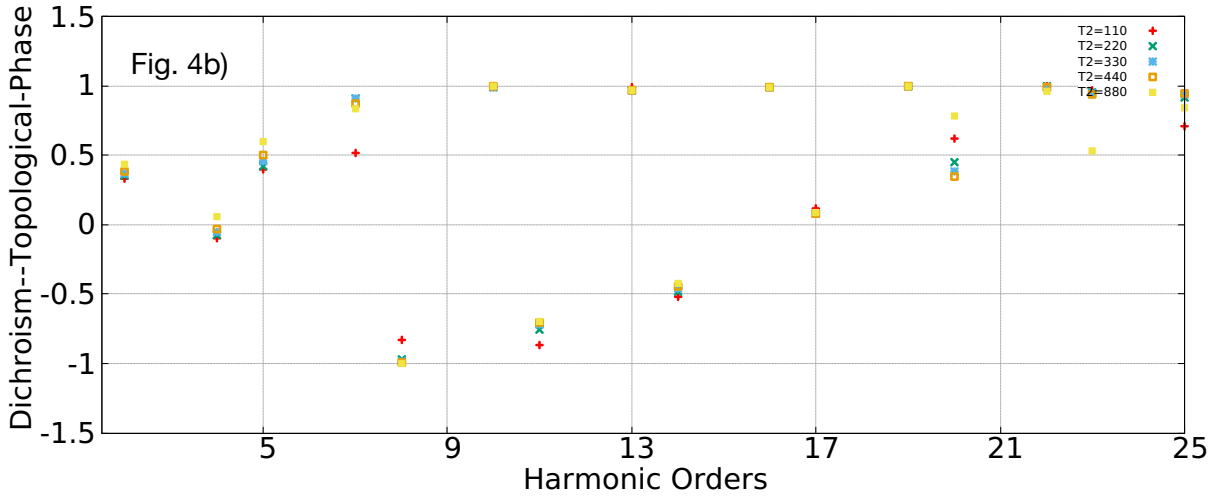


Fig 4b) shows the CD of the HHG spectrum for an non-trivial phase of HM with M0/t2 = 2.54, and phi0=1.16 rads for each HO as a function of the dephasing time T2.

These Fig 4a) — 4b) clearly show CD depends on the dephasing time for the HOs 3n+2 (some of them around 3n+1) around the plateau and cut-off. The most robust dichroism is observed for the nontrivial phase and HOs 3n+1.

One can infer easily or obviously than the **3n+1 CD** would be strongest one, once we try to scan topological phase transition along phi0 axis of HM and its phase diagram. Additionally, Fig 3a) is showing that t**his CD can potentially be sensitive to the respectively dephasing time used at each MAGNETIC FLUX PHASE, phi0**.

This dephasing time dependence of the harmonic yield with respect to phi0 or min band-gap between conduction and valence band, is the main source of noice for the CD shown in Fig 3a) along the trivial phase. This is a clear hythesis and obvious, since the dephasing time is a material dependent quantity, if you dont understand it, just, please go to literature and search by yourself.