

**Short visit report:**

Toward experimental tests of strong-field QED  
24–28 March 2014, Magurele

**Summary**

The visit was extremely fruitful. As well as affording us the time to make concrete progress on our current projects, I was able to establish new collaborations and initiate new projects both with the group of Prof. Florescu and with the ELI team.

The funding of research visits (through awards such as this Short Visit Grant) leads to collaborative opportunities which would otherwise be impossible to realise. As such it is one of the most efficient uses of funds for advancing research in the physical sciences. The trip to Magurele exemplifies this, and I thank SILMI for providing me this opportunity.

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**Purpose and aims**

The purpose of the visit to Magurele was twofold.

- 1) To investigate possibilities for collaboration with the research group of V. Florescu, in particular with regard to measuring strong field QED processes at facilities such as the currently in-construction ELI-NP (*Extreme Light Infrastructure – Nuclear Physics*) in Romania [1].
- 2) To continue work on a joint project with V. Dinu on vacuum birefringence in strong laser fields, for which Flagship experiments are planned at both HIBEF [2] and ELI-NP [1].

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**Work carried out during the visit**

- 1a) Met with O. Tesileanu and D. Ursescu, from the ELI team, regarding prospects for measuring strong-field QED processes at ELI (see below).
- 1b) Numerous discussions with V. Florescu and M. Boca on strong-field QED, in particular on the prospects for collaboration in this area (detailed below).
- 1c) Gave a seminar on “*Vacuum birefringence in strong laser fields*”.
- 1d) Visited the CETAL [3] and ELI-NP laser facilities.
- 2) Carried out, together with V. Dinu, numerical simulations related to the impact of beam shape and collision geometry on helicity-flip and vacuum birefringence processes in laser-laser collisions [4].

### Main results obtained

1a) There was considerable interest from the ELI team on measuring vacuum birefringence, on which I am currently working. Following the meeting with the ELI team I was invited to join the next TDR (Technical Design Report) regarding strong-field QED projects at ELI-NP. I have accepted and will contribute to this report, to be prepared later this year.

1b) We have identified several potential projects, see below, on which my own research group can and will collaborate with V. Florescu, M. Boca and V. Dinu.

2) V. Dinu and myself were able, during the week, to consolidate our numerical approaches for our shared project on vacuum birefringence. The majority of previous theoretical work in this area is based on simplistic laser models (constant or monochromatic fields), whereas measuring vacuum birefringence will require a high-precision experiment in which all sources of error and noise must be very well understood. This is the motivation behind our current project, which aims to carefully model the impact of realistic field geometries on the experimental signals of interest.

Having successfully compared and benchmarked our codes, we are now in agreement and in a position to consider realistic field configurations and collision geometries.

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### Future collaboration with host institution and projected publications

1) Planned projects with the group of V. Florescu:

- i) Prof. Florescu's group has expressed an interest in working on radiation reaction in laser-particle scattering. While normally a small effect, it is expected that radiation reaction effects will become significant at laser intensities reaching  $10^{23}$  W/cm<sup>2</sup> and above. We will investigate this topic based on a combination of previous results from both our research groups [5, 6].
- ii) Electron scattering from a nucleus within a laser field (resonant and non-resonant contributions).
- iii) Propagation in intense fields and incoherent approximations, with application to multi-photon processes and cascade formation.

(While it is too early to predict the number of publications resulting from these investigations, which have some overlap, SILMI support will be acknowledged.)

2) Continued projects:

- i) During the visit, progress was made on our second paper on vacuum birefringence, following [7]. The manuscript is now in preparation [4], with the provisional title "*Helicity-flip and vacuum birefringence in focussed laser pulses*". SILMI support will be acknowledged.

## References

- [1] Extreme Light Infrastructure: Nuclear Physics (ELI-NP), <http://www.eli-np.ro/>
- [2] HIBEF webpage: <http://www.hzdr.de/db/Cms?p0id=35325&pNid=1769>
- [3] CETAL homepage: <http://ioandancus.wix.com/cetal-pw-laser>
- [4] V. Dinu, T. Heinzl, A. Ilderton, M. Marklund, G. Torgrimsson, *to appear*.
- [5] M. Boca, V. Dinu and V. Florescu, Phys. Rev. A **86** (2012) 013414 [arXiv:1206.6971 [physics.atom-ph]].
- [6] A. Ilderton and G. Torgrimsson, Phys. Lett. B **725** (2013) 481 [arXiv:1301.6499 [hep-th]].
- [7] V. Dinu, T. Heinzl, A. Ilderton, M. Marklund, G. Torgrimsson, arXiv:1312.6419 [hep-ph].

