Dottorato di Ricerca in Fisica dell'Università degli Studi di Messina

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Aula E. Majorana,
Dip.to di Fisica e di Scienze della Terra, V.le F. Stagno d'Alcontres 31, S. Agata(ME)

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Principles of Complex Interferometry and its Applications in Laser-Matter Interactions

Classical interferometry is the key method in laser-produced plasma diagnostics. Its more *advanced* version, which allows *recording* and subsequent *reconstruction* of up to *three* sets of data from just *one* data object – a *complex interferogram*, was developed in the past and became known as *complex interferometry* (CI) [1]. By using CI, not only the usual *phase shift*, but also the *amplitude* of the probing beam as well as the *fringe contrast* (leading directly to the phase shift time derivative) can be considered *simultaneously*. The *origin* of CI idea can be traced back to measurements of *magnetic fields* spontaneously generated in laser-produced plasmas [2], where CI approach provided results with *spatial* resolutions *far superior* to those of any similar experiments performed to that time. It should be noted, that in these pioneering experiments the Fresnel-biprism-based *Nomarski* interferometer was already employed with its functioning *analyzed* later on in detail to suit the best for the *optimal* interferometer *setup* from the point of a subsequent complex interferogram *analysis* [3].

From its very beginning, the method of complex interferogram *analysis* was fully based on FFT. Therefore for *practical applications* of CI an appropriate *computer software* is required. Such software developed over the years by Kalal can be employed for *reconstructions* of *plasma density* profiles, *neutral gas density* profiles, profiles of *magnetic fields* spontaneously generated in laser-produced plasmas, etc. It can take care of *systematic errors* removal in the case of *imperfect alignment* of individual *optical* components of *any* interferometer used provided the *reference* signal-free interferogram is available. It should be noted that this software also contains FFT-based *Abel inversion* algorithm (most likely the *fastest* of all so far developed). Moreover, in the case of precisely known *test* data, this algorithm has been proven to be one of the *most accurate* [4]. In its recent upgrades the software also makes possible to go in the *opposite* direction and generate *phase shifts* from reconstructed *density* profiles as well as *interferograms* from the reconstructed *phase shifts*. This feature becomes very useful for *evaluation* of the reconstructed data *precision* and *reliability*.

Examples of the *functioning* of this *software* will be demonstrated, including *analysis* of the first interferograms recorded very recently at PALS using *fs* diagnostic laser (more details will be provided on specialized PALS *poster* dedicated to this topic).

[1] M. Kalal, Czechoslovak J. Phys. **41**, 743 (1991)
[2] M. Kalal, K.A. Nugent and B. Luther-Davies, J. App. Phys. **64**, 3845 (1988)
[3] M. Kalal, O. Slezak, M. Martinkova, and Y.J. Rhee, J. Korean Phys. Soc. **56**, 287 (2010)
[4] M. Kalal and K.A. Nugent, Appl. Opt. **27**, 1956 (1988)

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