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Innovative X-Gamma Ray Sources Based on Laser-Produced Plasmas

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Developments in laser technology with regard to infrared and visible light have been a rather fast and fairly easy process, for the availability of technologies capable of producing coherent, brilliant light in those ranges from the very beginning. Not the same fate befell ultraviolet and X-rays light technologies that had been stuck in their initial stage, not so much progressed since the days of their discovery, due to Röntgen towards the end of the nineteenth century. On the other hand, synchrotron light proved to be very interesting for the spectacular properties of brilliance, directionality, monochromaticity, tunability and coherence, which are all together interconnected and make these kind of sources the only capable of working in the X-rays range with so high efficiency and versatility. Behind the process of radiation emission that's realized in the storage rings, there's the presence of magnetic devices, namely bending magnets, undulators and wigglers, which interact with ultra-relativistic electron bunches, accelerating them in radial direction and stimulating energetic and collimated radiation beams. We don't describe exactly what synchrotron facilities actually are, nor we do an overview of the possibilities they offer to their users, but we want to talk about several new X-rays sources, whose mechanisms are in close analogy to those of synchrotrons. Two key points must be clear, in fact synchrotron experience teach us that in order to obtain high quality radiation, with really useful properties, we need a radial acceleration field and relativistic electronic bunches which interact with it. One could think: is it really necessary to put up large buildings, or even use macroscopic magnetic devices to achieve radial acceleration of relativistic charges ? We surely know that the to date developed technologies work well, but new trends in particle acceleration field are taking hold, actually bringing innovative ideas to radiation emission processes on their wake. In particular we're going to focus on the Thomson Scattering and on Betatron Radiation in plasmas. Clearly, the Thomson Scattering has all ingredients for the synchrotron radiation recipe, namely ultra-relativistic travelling electrons transversally accelerated by a counter-propagating electromagnetic field. On the other hand, riding the wave of new acceleration experiences, in which high intensity laser plasma interactions are involved, we can easily imagine, in a not too distant future, to get rid of the LINACs, giving birth to new X-rays Thomson sources that work with the only laser devices. Betatron radiation in Laser-plasma acceleration experiments is the radiation emitted by longitudinally accelerated electronic bunches which interact, in the so-called bubble regime, with an electrostatic ionic radial field, generated by ion charges, in a region deeply depleted of electrons by the high intensity laser ponderomotive forces. Even if its characteristics have been only recently investigated, Betatron radiation seems to be a very promising pulsed source in the X-gamma ray range.

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