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Extreme Light Laser: Analyzing the texture of matter from the atom to vacuum

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On the eve of the laser's fiftieth anniversary, we cannot but marvel at the astounding progress accomplished since the first laser shot rang in the Hughes Research Laboratory May 1960. The range of the laser applications is stupefying. At one extreme, It can be used to slow down the atoms to almost a complete stop in order to investigate its structure with meticulousness or make, ultra accurate clocks. At the other extreme, laser light can provide enormous electric fields capable of accelerating electrons from rest to close to the speed of light over only a fraction of a micrometer in a femtosecond, leading to extremely compact laser accelerator for material science, medical and environment applications. In the near future, the laser will produce pulses with peak power in the exawatt regime or hundred thousand times the world grid power during few femtoseconds. This laser called ELI for Extreme Light Infrastructure, is being designed and constructed in Europe. It will produce bursts of High energy particles and radiations in the attosecond and zeptosecond range and will be the gateway of a new laser-matter interaction régime : the ultra relativistic regime where not only electrons but ions are thrust to relativistic velocity. Finally, its intensity will be so large that it will be able to break down the vacuum into its fundamental elements and hence offering a new paradigm to analyze the texture of vacuum.