The Hebrew University of Jerusalem , Colloquium

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"Ultra High Intensity Laser: New high energy physics paradigm"

Laser technology has developed to the point where we can now contemplate using lasers as tools complementary to the current use of conventional high energy accelerators. Focusing these extremely high power lasers to a very small diameter spot produces extremely high intensities, which allows basic questions of the fundamental structure of matter and the vacuum to be investigated directly with lasers – this is the new paradigm. Laser-driven particle accelerators utilise plasma to accelerate particles to high energies in distances that are 10,000 times shorter than conventional accelerators. This makes them very compact and, in principle, enables the maximum particle energy to be substantially increased. For instance it could be possible to accelerate particles to the PeV energies relevant to astrophysics. Current technologies would require an accelerator that would girdle the earth (40,000km) – but with laser acceleration, the same particle energy could be obtained over a kilometre. This possibility offers astrophysicists the prospect of producing and studying high-energy particles on earth that are usually only found in space. The bursts of particles provided by the laser will be extremely short, on the atto-zepto second scale and could simulate gamma rays or high energy particle bursts crossing the entire universe. I will describe how ultra-compact x-ray free-electron lasers can be constructed using laser-based accelerators – which will allow holograms of large molecules relevant to many industries to be produced.