Laser Fusion and Exawatt Lasers

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(PhysOrg.com) -- In the recent past, producing lasers with terawatt (a trillion watts) beams was impressive. Now petawatt (a thousand trillion watts, or 10^15 watts) lasers are the forefront of laser research. Some labs are even undertaking work toward achieving exawatt (10^18 watts) levels.

Todd Ditmire at the University of Texas currently produces petawatt power through a process of chirping, in which a short light pulse (150 femtoseconds in duration) is stretched out in time. This longer pulse is amplified to higher energy and then re-compressed to its shorter duration, thus providing a modest amount of energy, 190 joules in a very tiny bundle.

Ditmire claims that his petawatt device has the highest power of any laser system now operating, even the one at the National Ignition Facility at the Lawrence Livermore National Lab, owing to the very short pulse-compression he and his colleagues use.

The main research use for the Texas Petawatt Laser, as it is called, has been to produce thermonuclear fusion; the laser light strikes a target where fusion of light nuclei occurs, releasing neutrons into the vicinity. These neutrons can themselves be used for doing research. The first results of this fusion experiment will be presented at this meeting. Other applications include the study of hot dense plasmas at pressures billions of time higher than atmospheric pressure and the creation of conditions for accelerating electrons to energies of billions of electron-volts.

Another figure of merit for a laser, in addition to power, is power density. The Texas device is capable of producing power densities exceeding 10^21 watts per square centimeter. At this level many novel interactions might become possible.

To get to exawatt powers, Ditmire hopes to combine largely-existing laser technology and his already-tested 100-femtosecond pulses with new laser glass materials that would allow amplification up to energies of 100 kilo-joules. Ditmire's current energy level, approximately 100 joules, is typical of laser labs at or near the petawatt level, such as those in Oxford, England, Osaka, Japan and Rochester, N.Y. With support from the government and the research community, building an exawatt laser might take 10 years to achieve, Ditmire estimates.

Scientists will present their paper "The Texas Petawatt Laser and Technology Development toward an Exawatt Laser" at the Optical Society's Annual Meeting, Frontiers in Optics, on Tuesday, Oct. 13. The meeting takes place at the Fairmont San Jose Hotel and the Sainte Claire Hotel in San Jose, Calif.

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