A near infrared, high-power gas laser: the iodine laser *

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The iodine laser has all the main features required to carry out light-matter interaction experiments, chiefly those aimed at demonstrating inertial confinement fusion.

Pulse durations from 0.1 to 100 ns can be generated. Energy can easily be stored, up to several J/l and extracted from amplifiers with efficiency ranging from 25 to 50% depending on pulse duration, yielding beam flux densities 2 to 5 J/cm^2, well within the capabilities of present day dielectric coating damage thresholds. Moreover a clear understanding of the physics allows one to predict beam amplification characteristics through a large system.

As a gas laser, the iodine beam quality can be maintained at a high level during propagation through an amplifying laser chain: beams at 3 times the diffraction limit have been demonstrated at the 1 TW level.

The most widely used way of pumping the laser is by U. V. induced photolysis of perfluoroalkyl molecules (CF_3I, C_3F_7I), the U. V. light being produced by flashlamps. By-products of the reactions, some of them being quenching agents for the upper laser level atoms, can be eliminated between firings in traps included in a closed loop gas circuit.

Two unique features grant the iodine laser a great deal of flexibility: first, the cross section for stimulated emission can be ajusted very simply through collision broadening by addition of a buffer gas (Ar, SF_6). This allows one to adjust the small signal gain and the saturation parameters. Second, the stored energy as well as its spatial variation can be adjusted via partial pressure of the perfluoroalkyl.

Recent developments at C. G. E. have shown that very large diameter amplifiers can be envisioned. When using a classical pumping geometry, where the pump energy is provided at the periphery of the active medium the stored energy decreases as the diameter increases. A new type of amplifier, which does not have that limitation has been built for which the U. V. flashlamps are inside the active medium, installed in three separate layers about 10 cm apart and parallel to the optical axis. The clear aperture is 38 cm in diameter for 170 cm active length. The stored energy is at least 4 J/l with a 0.6% electrical efficiency. The optical quality of the amplified beam has been checked out by optically coupling this amplifier to an experimental laser chain delivering 20 J in a 1 ns pulse.

Since laser action occurs at 1.315 μm, the iodine laser wavelength is reasonably well-suited to target experiments. Being close to that of Nd-glass laser, its wavelength allows one to make use of all the electro-optical hardware developed for glass laser. Existing technology is able to support the design and fabrication of multi-kJ systems.

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近红外高功率气体激光器：碘激光器

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碘激光器具有进行光与物质相互作用实验，特别是以惯性压缩聚变为目标的实验所要求的主要特性。

它所能产生的脉冲持续时间从0.1到100毫微秒，能量很容易储藏，高达每立升几焦耳，从放大器中提取能量的效率依赖于脉冲持续时间，其值在20～50%范围内，所产生的束流密度为2～5焦耳/厘米^2，远低于目前介质涂层的破坏阈值。而且，透彻了解其物理过程能使我们预知大系统的光束放大特性。

作为气体激光器，在经过放大系列后碘光束的质量可以维持在高的水平：在1兆兆瓦的功率水平上获得三倍衍射极限的光束。

泵浦激光器最广泛采用的方法是由紫外光引发氟代烷分子(CF_3I，C_3F_7I)的光分解，紫外光由闪光灯产生。有些反应副产物会猝灭激光上能级原子，副产物可在脉冲间隔时间内通过闭合气体回路中的冷阱而消除。

二个独特的性质使碘激光器具有很大的灵活性：首先，可以简单地依靠添加缓冲气体(Ar，SF_6)所引起的碰撞加宽来调节受激发射截面，这就可以调节小信号增益和饱和参量。其次，改变氟代烷的分压可以调节储能及其空间分布。

通用电器公司最近的发展表明可以获得很大口径的放大器。当采用经典的泵浦结构时，泵浦能量提供给激活介质圆柱体的外围，当直径增大时，储能就会减小。一种不受上述情况限制的新型放大器已经建成，紫外闪光灯分三层平行于光轴，装设于激光介质内部，层间距离是10厘米。有效孔径的直径38厘米，激活长度170厘米。储能至少每立升4焦耳，电效率为0.6%。检验放大光束光学质量的方法是将这个放大器光学耦合到一个脉宽1毫微秒、能量20焦耳的实验性激光器系列上。

由于激光波长为1.315微米，碘激光波长很适合于靶实验。由于这一波长接近于钕玻璃激光器的波长，可使用玻璃激光器所使用的全部电光元件。现有的技术能保证设计和制造几千焦耳的系统。