I will discuss four general areas of the oxygen-iodine chemical laser. First, the basic physics and chemistry of the device; second, kinetic measurements of rate constants in both the free iodine atom regime, and third, the region in which I₂ dissociation is occurring. These kinetic experiments will then be compared with real laser systems. Finally, I will describe the diagnostics being used in the oxygen-iodine system.

The oxygen-iodine chemical laser operates due to the fast, nearly resonant transfer between the first excited state of oxygen and the spin orbit components of the iodine ground state. This reaction, which comes to the equilibrium in the device, is slightly downhill which accounts for its greater than unity equilibrium constant. Because of this equilibrium constant and the degeneracies in the iodine atom, if an excited oxygen to total oxygen of greater than 1/6 is produced, then an inversion exists on the iodine atom.

The key questions which must be answered to build an efficient oxygen-iodine chemical laser are how to produce large fractions of excited oxygen, and how to produce iodine atoms.

The production of \( ^1\Delta \) oxygen occurs through the heterogeneous gas-liquid reaction between chlorine and basic hydrogen peroxide. This reaction has a unit quantum efficiency and the long lifetime and stable character of excited oxygen allows separation from the liquid phase. Yields of greater than 82% excited oxygen have been observed.

The details of the chemistry of excited oxygen production are not well known. However, it is suspected to involve the direct
reaction of chlorine in solution with the hydroperoxy anion.

I will now describe the kinetics in the free iodine atom regime; i.e., that regime in which all the I\(_2\) that has been put into the flow has been dissociated.

In the absence of contaminants from the generator, which are largely chlorine and water, and when the I\(_2\) has been totally dissociated, the performance of the laser depends only on four reactions.

\[
\begin{align*}
0_2 (^{1\Delta}) + I \xrightarrow{k_f} & \quad 0_2 (^3\Sigma) + I^* \\
0_2 (^{1\Delta}) + I \xrightarrow{\beta_f \cdot k_f} & \quad 0_2 (^3\Sigma) + I \\
I^* + 0_2 (^3\Sigma) \xrightarrow{k_r} & \quad I + 0_2 (^{1\Delta}) \\
I^* + 0_2 (^3\Sigma) \xrightarrow{\beta_r \cdot k_r} & \quad I + 0_2 (^3\Sigma)
\end{align*}
\]

The first two reactions are the forward and reverse transfer rates. Their nonresident rates are also indicated here. The third reaction is the feedback reaction between \(^1\Delta\) and the I\(^*\) which produces a \(^1\Sigma\), and finally the pooling reaction between two \(^1\Delta\)'s. All of these reactions have been redetermined and found to be independent of temperature and to be near the previously accepted values.

For example, the energy pooling rate between two \(^1\Delta\)'s has been measured at several places, including the McDonnell Douglas Research Laboratory and The Aerospace Corporation, at a number of temperatures. The rate is essentially independent of temperature and equal to \(2 \times 10^{17} \text{ cm}^3/\text{mo/sec}\).

It was originally proposed by Derwent and Thrush that the I atoms were produced in the \(^1\Delta\) oxygen flows by the reaction of I\(_2\) with \(^1\Sigma\) oxygen which had been produced by pooling processes. However, Houston, et al, have recently remeasured this rate and it is much slower than thought by Derwent and Thrush and is therefore too slow to account for the observed rate of dissociation of I\(_2\) in excited oxygen flows. Furthermore, both in our own laboratory and at The Aerospace Corporation, we found that I\(_2\) dissociation occurs in