A low cost, copper heat pipe oven

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Why use Copper instead of stainless steel?

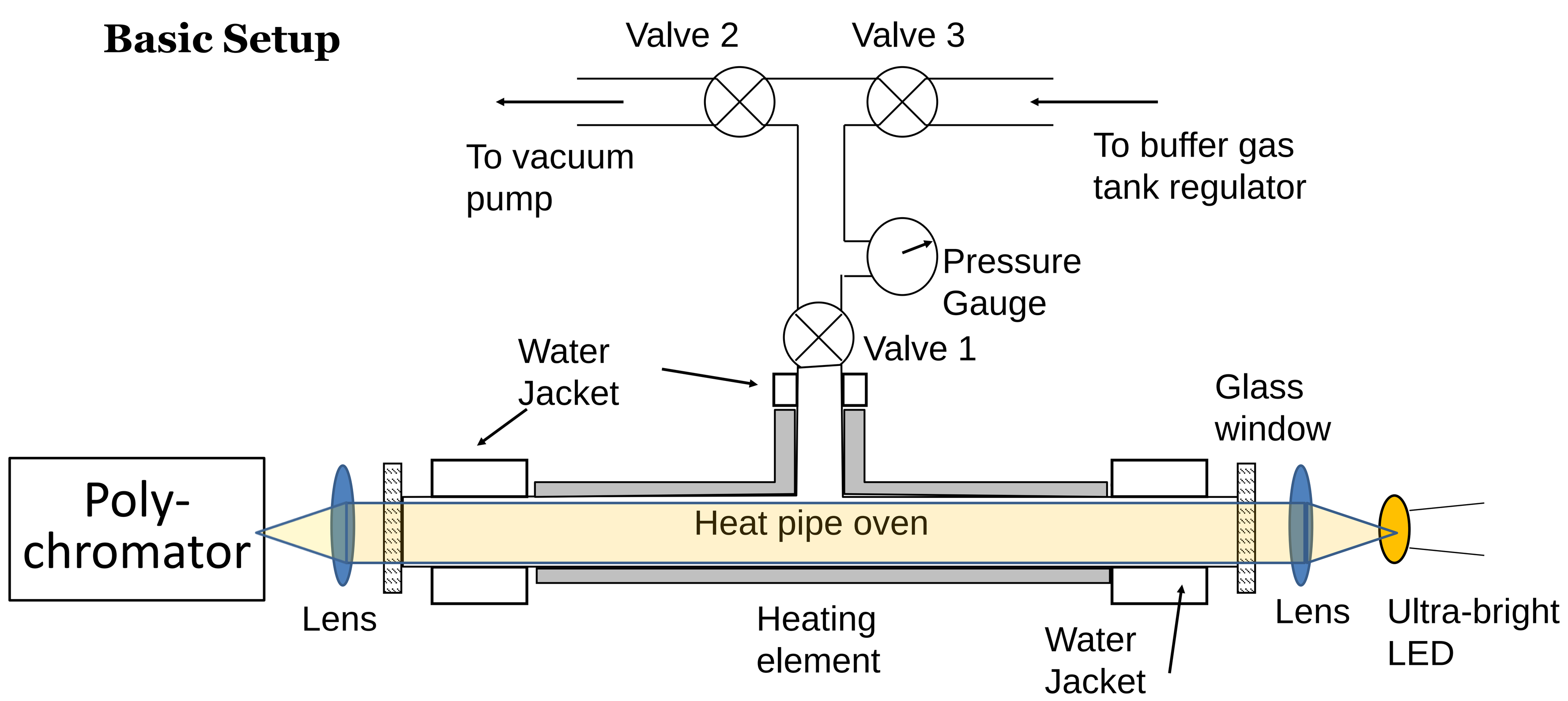
- Lower cost of materials and assembly
- Quick heat ups and cool downs compared to stainless steel (ideal for advanced instructional physics labs)
- Copper does not disturb magnetic fields as much as stainless steel

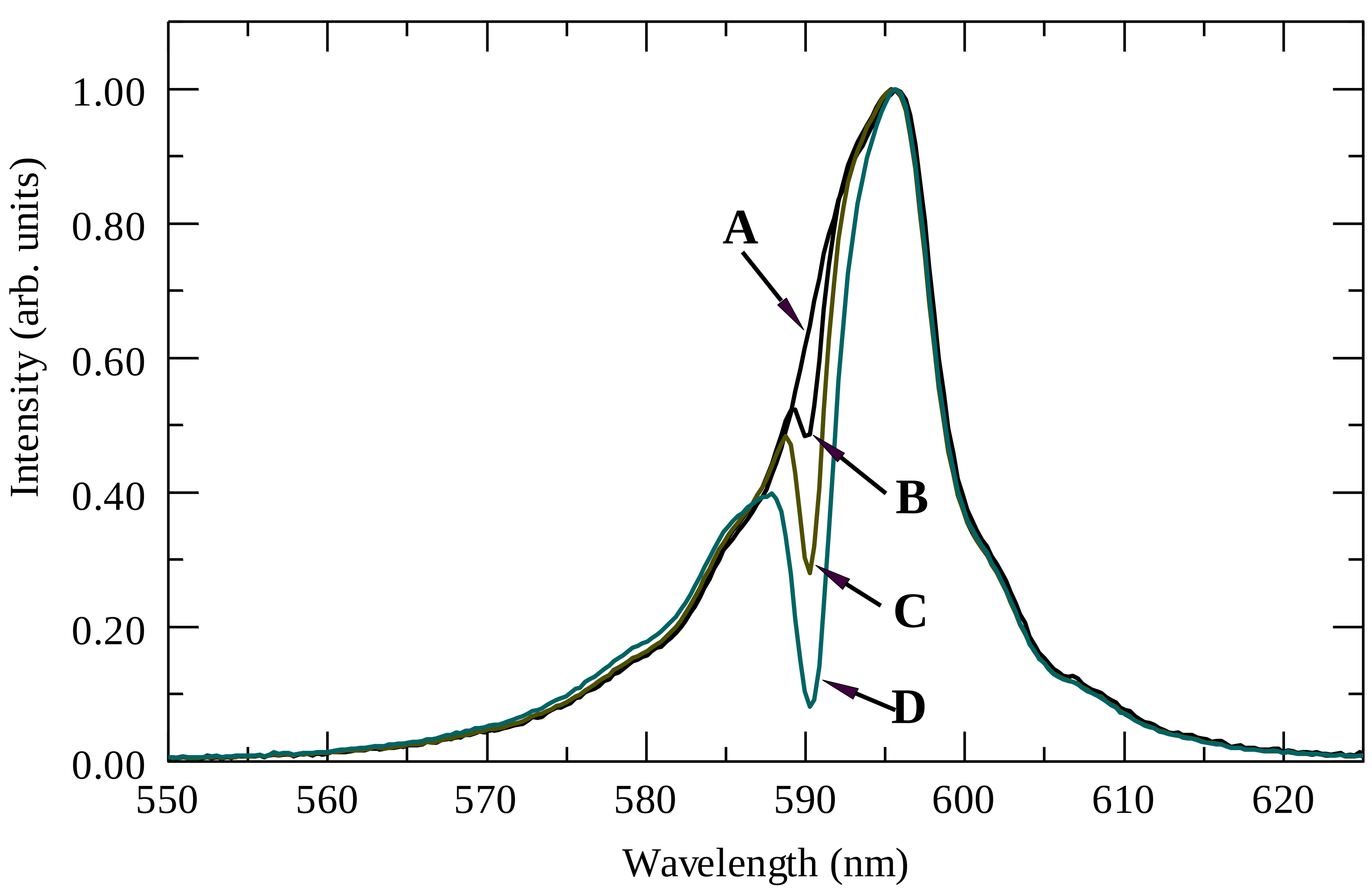
Construction of our Copper Heat Pipe Oven

- Use common sweat copper tubing adaptors (Copper Alloy 122; this is a phosphorus deoxidized copper that is 99.9% Cu and 0.02% P)
- Braze pieces together using "Braze 721" which is ~ 27% Cu and ~ 73% Ag).
  - While brazing, we flow Argon gas through the tubing to prevent oxidation of the copper and braze material on the inside.
  - This braze is ideal for applications where magnetic fields are important [Magnetic susceptibility (cgs) for copper is -5.46×10^{-6} and for silver is -19.5×10^{-6}].
  - The melting point of this braze material is ~ 779°C. This requires the use of an air-acetylene torch.
- Heating element is made using twisted pairs of Ni-Chrome A and copper magnet wire encased in fiberglass sleeving.
  - Twisted pair minimizes the magnetic field produced while current runs through the heating element.
  - Using all Ni-Chrome wire (instead of copper) produces local hot spots which melts the fiberglass insulation.
  - The heating element is attached to the heat pipe oven using furnace cement.

Example Experiment: Light Absorption by Sodium Vapor

Basic Setup

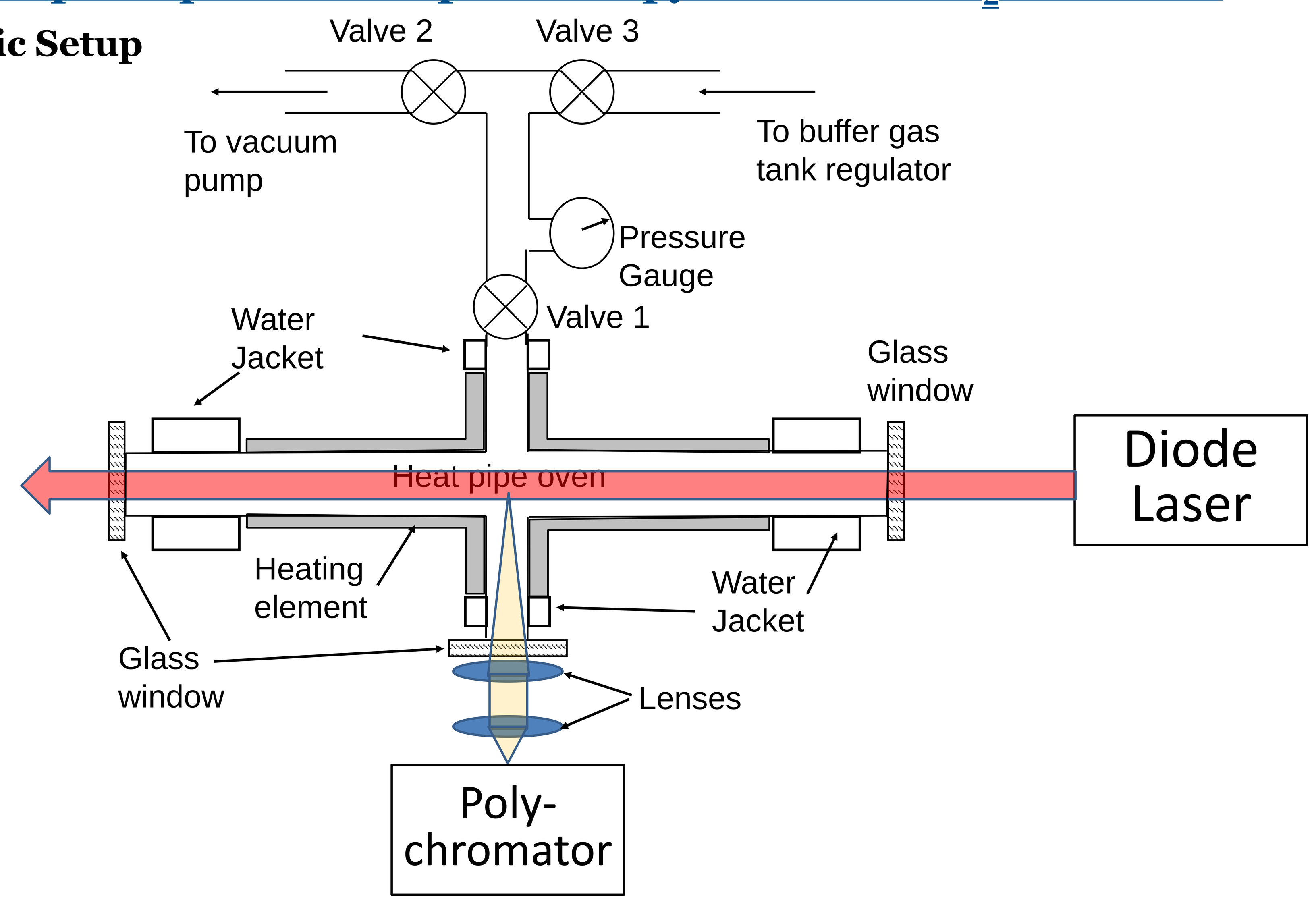


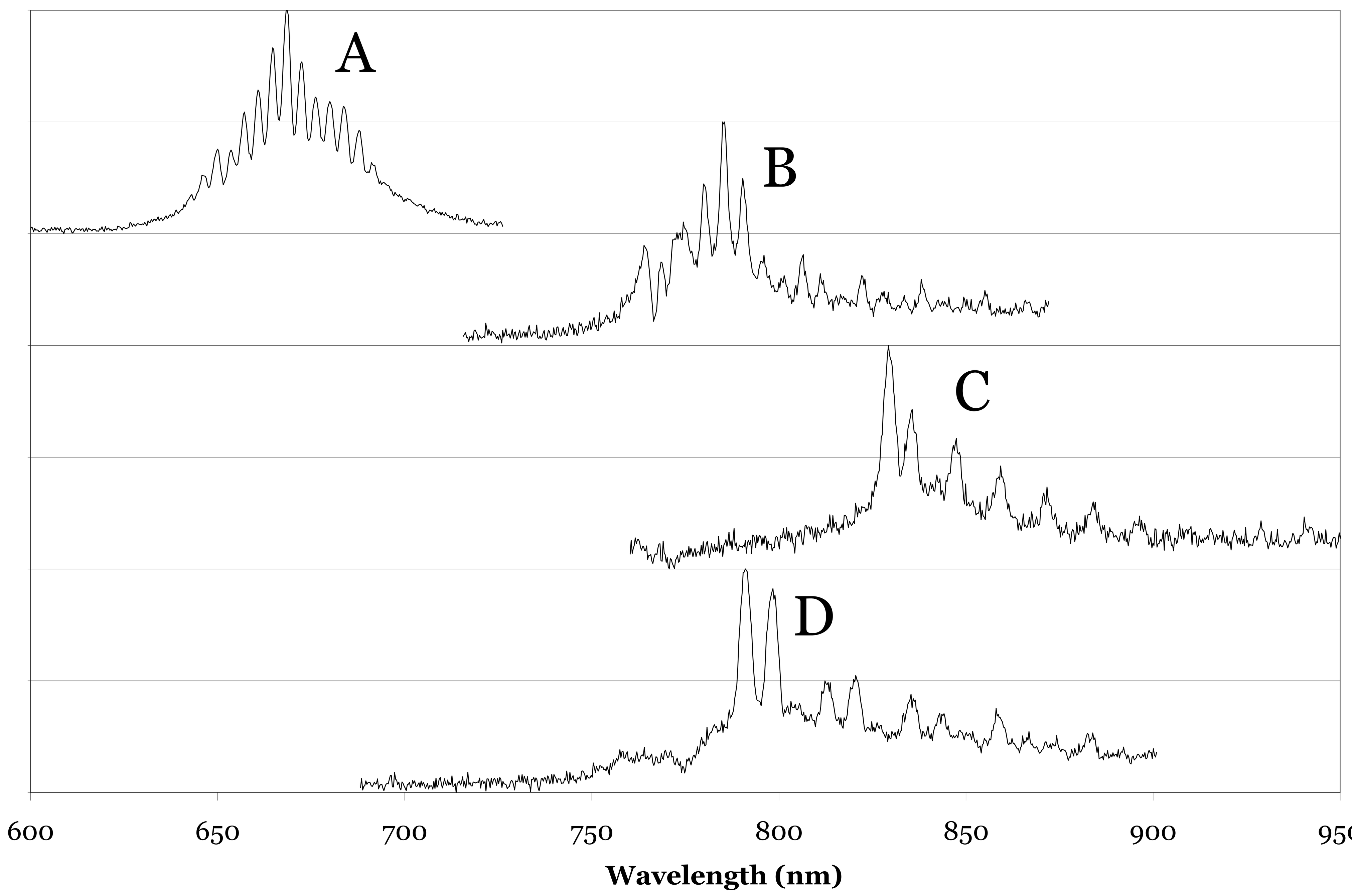


Spectra of the high intensity LED transmitted through the Na vapor at various oven temperatures. A) Room temperature oven (20°C). B) Oven at 366°C. C) Oven at 418°C. D) Oven at 478°C.

Example Experiment: Spectroscopy of NaK and K_2 molecules

Basic Setup





Laser induced fluorescence spectra observed from K_2 and NaK with various excitation wavelengths: A) K_2 spectrum corresponding to $1^1\Pi_u \rightarrow 1^1\Sigma_g^+$ transitions with 660 nm laser excitation. B) K_2 spectrum corresponding to $1^1\Sigma_u^+ \rightarrow 1^1\Sigma_g^+$ transitions with 785 nm laser excitation. C) K_2 spectrum corresponding to $1^1\Sigma_u^+ \rightarrow 1^1\Sigma_g^+$ transitions with 830 nm laser excitation. D) NaK spectrum corresponding to $2^1\Sigma^+ \rightarrow 1^1\Sigma^+$ with 785 nm laser excitation. Note that the spectra are not rotationally resolved and we only can see the centroid of the emission corresponding to a blending of the different rotational transitions that correspond to the transitions to a particular vibrational level in the ground state. Typically, the laser wavelength corresponds to the largest observed peak in the spectrum. This peak is a combination of scattering and fluorescence. The laser wavelength was confirmed either by cooling the oven while the laser is held at a constant temperature and current (to maintain a constant wavelength), or by sampling the transmitted laser light.

Future Plans: Optical Pumping Experiments with Rb