different colors of light. Lasers are tuned to emit a carefully chosen combination of colors that will be absorbed by only U^{235}. The laser-excited U^{235} atom emits an electron and becomes a positively charged ion. The U^{235} ions are then separated from neutral U^{238} using electromagnetic fields.

The AVLIS process consists of a laser system and a separator system. The latter contains a vaporizer and a collector. The working medium is metallic uranium that is melted and vaporized to form an atomic vapor stream. The vapor stream flows through the collector where it is illuminated by precisely tuned laser light. The selected atoms become charged by photoionization and are removed from the vapor stream by an electronic field.

The laser system is a laser-pumped laser, that is, one laser system is used to energize a second, which finally produces the light used in the separation process. This allows the separation of the requirements for efficiency and color precision. The large pump lasers are reasonably efficient, whereas the dye lasers (which convert the pump laser light to process light) are tunable, reliable, and commercially available.

When the laser light illuminates a stream of uranium vapor, the U^{235} vapor absorbs the light but the U^{238} does not. The now excited U^{235} ejects an electron, thus becoming a positively charged atom or ion which is deflected by an electromagnetic field to the product collector. The U^{238} remains uncharged and passes through the collector section to the tails collector.

The vaporization of the uranium is accomplished by means of an electron beam that creates an atomic U^{235}/U^{238} vapor stream.

MLIS uses UF_6 as its feedstock, thereby fitting more readily into the conventional fuel cycle than AVLIS. There are two steps involved in the MLIS process: excitation with infrared lasers and then dissociation with an ultraviolet laser. Gaseous UF_6 mixed with a carrier gas (argon) is expanded through a nozzle that cools the gas to low temperatures. The UF_6 is irradiated by infrared lasers, which selectively excite the $U^{235}F_6$, leaving the $U^{238}F_6$ unexcited. Photons from an ultraviolet laser then preferentially disassociate the excited $U^{235}F_6$ to form $U^{235}F_5$ and free fluorine atoms. The $U^{235}F_5$ formed in this manner precipitates from the gas as a solid powder which can be filtered from the gas stream.

11.3.6 Plasma Separation

The plasma (fluid or vapor composed of charged particles) method of separation is based upon the fact that the cyclotron frequency of an ion in a magnetic field is a function only of the ion mass and the magnetic field strength. Accordingly, by exciting plasma comprising uranium ions and electrons at the cyclotron frequency of the U^{235} ions, it is possible to *pump energy* into the U^{235} selectively and thereby increase the orbit diameter of the U^{235} ion relative to that of the U^{238} ion. Collection schemes are based on the difference in orbit diameter between the U^{235} and U^{238} ions as they traverse the length of the plasma orbiting around the field lines of a high-strength solenoidal magnet. The excitation of the U^{235} is accomplished by placing in this plasma a radiofrequency antenna tuned to the U^{235} cyclotron frequency. The separation performance of a single separator is adequate enough to cover the isotopic gradient of interest so that staging will not be required.

11.3.7 Aerodynamic Processes

There have been two aerodynamic separation methods developed and tested. One, in Germany, is the separation nozzle, referred to as the *Becker jet nozzle*. The other is the vortex tube separation technique developed in South Africa. In both processes, the separation