# Positron Cooling, Trapping and Transport in Gases

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Positrons are now widely used in materials and bioscience. Their annihilation with their matter counterpart, the electron, provides the gamma ray signature that is used for a variety of applications, from polymer design to cancer imaging and therapy. We have commenced a program of studies aimed at a better understanding of positron interactions and transport in gases and, ultimately, soft condensed matter.

Positron interactions with gases are characterized by a number of significant differences from those of electrons, which are now well studied and understood. Positrons do not undergo the exchange interaction which, in the case of electrons, is responsible for many spin-flip excitations. They do however readily form positronium – an electron-positron pair – which is one of the major pathways to annihilation, and is clearly a non-conservative process.

We have an experimental program underway on positron interactions with atoms, molecules and materials. At the heart of this program is a 'Surko trap' where positrons are accumulated, trapped and cooled through controlled interactions with molecular gases such as $N_2$ and $CF_4$. The principle interactions in the trap are initially, electronic excitation of the $N_2$ molecules in which the positrons lose ~ 8 eV of energy and become trapped in a potential well and, finally, vibrational and rotational excitations of both the $N_2$ and the $CF_4$, which cool the positrons to room temperature.

This paper will briefly investigate what we understand about the cooling and trapping processes, the way in which these compete with annihilation via positronium formation, and the unique role that positronium formation plays in the transport of low energy positrons in atomic and molecular gases.