Atomic Physics Processes Important to the Understanding of the Scrape Off Layer of Tokamaks

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The region between the well confined plasma and the vessel walls of a magnetic confinement fusion research device, the scrape off layer (SOL), is typically rich in atomic and molecular physics processes. The most advanced magnetic confinement device, the magnetically diverted tokamak, uses a magnetic separatrix to isolate the confinement zone (closed flux surfaces) from the edge plasma (open field lines). Over most of their length the open field lines run parallel to the separatrix, forming a thin magnetic barrier with the nearby vessel walls. In a poloidally-localized region, the open field lines are directed away from the separatrix and into the divertor, a region spatially separated from the separatrix where intense plasma wall interaction can occur relatively safely. Recent data from several tokamaks indicate that particle transport across the field lines of the SOL can be somewhat faster than previously thought. In these cases, the rate at which particles reach the vessel wall is comparable to the rate to the divertor from parallel transport. The SOL can be thin enough that the recycling neutrals and sputtered impurities from the wall may refuel or contaminate the confinement zone more efficiently than divertor plasma wall interaction. Understanding neutral transport through the SOL is key to understanding particle balance and particle and impurity exhaust. The SOL plasma is sufficiently hot and dense to excite and ionize neutrals. Ion and neutral temperatures are high enough that charge exchange between the neutrals and fuel and impurity ions is fast. Excitation of neutrals can be fast enough to lead to nonlinear behavior in charge exchange and ionization processes. In this paper the detailed atomic physics important to the understanding of the neutral transport through the SOL will be discussed.