

Direct observation of the Coulomb explosion in exotic atoms

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In a series of experiments for a precision determination of the pion mass pionic and muonic X-ray transitions have been systematically investigated. The pions, produced in the accelerator facility of the PSI, Villigen, have been slowed down in the gas cell of a cyclotron trap to be captured by the gas atoms in highly excited bound atomic states. During the consequent radiative deexcitation processes characteristic X-rays were emitted, which are analyzed by a high resolution doubly focussing crystal spectrometer and registered in a optimized CCD detector system with high spatial granularity. Part of the pions decay to muons which undergo the analogue processes and are measured simultaneously. When comparing the spectra of di-atomic systems (Nitrogen,Oxygen) with those of mono-atomic systems (Ne) for the first time a broadening of the X-ray lines in the former case has been observed, which is attributed to the Doppler shift of the recoiling di-atomic Systems due to Coulomb explosion of the corresponding molecules. A study of the intensity dependence of parallel transitions as a function of pressure supports this interpretation. With a simple model the relevant charge states of the recoiling fragments have been estimated to be predominantly 3 or 4.