Microwave ionization of Rydberg atoms is a complex process, difficult to understand in full detail [1]. However in certain cases the main features present in the ionization spectra can be explained in terms of electronic transitions within a same shell. For instance the importance of this intrashell transitions is the key to explain multiphoton resonances observed when the Stark DC splitting is an integer multiple of the microwave frequency. This kind of resonances could be described in terms of the pseudospin formalism and position, width and strength of the resonances obtained [2].

In the pseudospin formalism the dynamic of hydrogenic Rydberg states within a manifold of principal quantum number $n$ is described in terms of two independent pseudoparticles with constant spin magnitude $(n-1)/2$ quantized in two independent directions. Each of the pseudospins can be decomposed into $(n-1)$ spin-1/2 components and, using Majorana reduction, the dynamics in external time-dependent fields can be expressed in terms of the dynamics of a two-state system of particles with spin-1/2 [3].

In addition the dynamics of spin-1/2 particles in oscillating fields and two-level systems in electromagnetic radiation fields are formally identical. In the later case, resonances were found whenever the level splitting is equal to $\omega = N\Omega$, where $\Omega$ is the photon energy. This condition was obtained theoretically by using Rotating Wave approximation. However there is a shift due to the counter-rotating wave, which is neglected in the approximation. This effect, called Bloch-Siegert shift, was initially calculated for case of one-photon resonance and then extended to the many-photon case [4].

In the present work, multiphoton resonances were observed for the case of an electric field rotating with a frequency of the order of the MHz in the same plane of a DC electric or magnetic field. These resonance transitions were measured for Li excited to $n = 25$ circular state by determining the survival probability of the initial state after the application of a circular rotating field for a short time ($\simeq 2\mu s$). Position and width of the resonances involving up to 23 photons were measured as a function of the amplitude of the rotating field and a systematic shift to higher values of the frequency for increasing amplitude was found.

Adiabatic Perturbation and Multichannel Landau-Zener models were applied within the pseudospin-1/2 formalism and analytical expressions for the Bloch-Siegert shifts and the resonance width were derived. The agreement between theory and experiment is excellent.

References