Proton Electromagnetic Form Factors in Space and Time-Like Regions

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The aim of this report is to review the present knowledge on electromagnetic hadron form factors (FFs), as they are understood at the present time, to summarize and analyze the present experimental results and available theoretical models and to open a view on future perspectives.

Electromagnetic FFs are fundamental quantities, which describe the internal structure of hadrons and the dynamic behaviour of their charge and magnetic distributions. Although experiments and theories have started to develop since decades, recently the opening of new experimental possibilities has driven an intensive and renewed activity in the field. In particular the development of high intensity, high polarized electron beams, large solid angle spectrometers and proton and neutron polarimeters in the GeV range opened the possibility to apply the polarization method suggested in the 70's by the Kharkov School. The precise data which have been obtained, mostly at JLab, have shown that the behavior of the electric and magnetic distributions inside the proton are different. In particular the electric FF does not follow a dipole distribution, and might even cross zero and become negative at large momentum transfer. At electron-positron facilities, on one side, the quasi real electron method has been successfully applied (called initial state radiation (ISR)), allowing to measure FFs in a wide time-like kinematical region (BABAR,SLAC), on the other side, the BES collaboration will measure very precisely proton and neutron FFs in the threshold region. In next future an antiproton beam with momentum up to 15 GeV/c will be available at FAIR (Darmstadt) and measurements by the PANDA collaboration should allow firstly the individual measurement of electric and magnetic FFs in the time-like region at relatively high momentum transfer.

This will drive the effort forward a global description of FFs in the full kinematical region. We will describe few models which are constructed with the relevant analytical properties, such as those based on dispersion relations and vector meson dominance. Moreover we describe an attempt of a physical interpretation of FFs in space and time-like regions.