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Saturn's radiation belts in the view of Cassini's MIMI/LEMMS observations

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Energetic charged particle measurements by Cassini's MIMI/LEMMS detector between 2004 and 2013 have revealed that the processes which form and sustain Saturn's radiation belts differ significantly for their electron and ion components. The permanent MeV ion belts are relatively stable in intensity over both short and long time scales, they have a outer boundary that continuously coincides with the L-shell of Saturn's moon Tethys (L=4.89) and comprise different sectors, each separated from the other by an ion depleted region that is centered on an L-shell of one of the planet's inner icy moons. Fluxes within these belts are dominated by secondaries that result from nuclear collisions between Galactic Cosmic Rays and the planet's main rings and atmosphere. Extensions of the ion belts beyond the orbit of Tethys, that may last several months, may occur after the interaction of Saturn's magnetosphere with a Solar Proton Event. Still, these transient extensions have no impact on the structure of the inner belts, making these inner belts ideal for detailed and a precise studies of nuclear source processes, such as CRAND. Contrary to the ion belts, the electron radiation belt is a continuous structure that extends between the outer edge of the main rings and has its outer boundary at an average distance of about 8 Saturn radii from the planet. The latter distance scatters considerably from orbit to orbit, while flux levels within the belt may vary by several orders of magnitude. MIMI/LEMMS observations show a series of interesting features, such as recurrent sudden belt expansions with periods in the order of one to several weeks and considerably variable responses following periods of ICME interactions with Saturn's magnetosphere. As the elecron belts extend until the very dynamic middle magnetosphere and the dominant electron source and loss processes change as a function of L-shell, energy and pitch angle, modelling of these belts is very challenging.