Prof. Dr.-Ing. Heiner Klinkrad

Institute of Space Systems, TU Braunschweig, Germany

Former Head of ESA's Space Debris Office, Darmstdt, Germany

Space Debris – An Underestimated Environmental Problem

The residues of more than 60 years of space flight, commonly known as “space debris”, are of a growing concern, primarily to space missions, but also (though to a much lesser extent) to the world population, in the case of re-entries. By the year 2020 some 28,000 objects had been detected, and were regularly tracked by sophisticated space surveillance networks. Their detection thresholds are ranging from about 10cm in low Earth orbits (LEO) up to 1m in the geostationary ring (GEO). In experimental modes objects down to sub-cm sizes can be detected. Such data suggest that the total number of objects of diameters >10 cm, >1 cm, and >1 mm is on the order of 34,000, 900,000, and 130,000,000, respectively. It is known that collisions with objects >10 cm will lead to a total disintegration even of large satellites, impacts by objects >1 cm will most likely cause the end of a mission, and hits by objects of >1 mm may disable sensitive spacecraft subsystems. Of the known, “cataloged” population of ~28,000 space objects only ~1,500 are operational spacecraft. The majority, however, ~10,000 objects, are caused by on-orbit break-up events, dominated by explosions and collisions. Based on long-term forecasts of the debris environment, collisions are expected to become the by far dominating contribution within a few decades. The probability of collisions is driven by the on-orbit cross-section, while the severity of collisions is driven by the on-orbit mass (currently ~8,500 tons). With the advent of LEO satellite constellations, consisting of several thousand spacecraft, this collision risk is further increased.

The presentation will provide an insight into the sources of the current space debris population, give a coarse assessment of associated risks and ways to mitigate them, and provide a long-term forecast of the debris environment under different assumptions of compliances of space actors with recommended debris mitigation measures. A concluding set of recommendations will outline ways to inhibit the uncontrolled growth of the debris population (known as the “Kessler Syndrome”).