Temporal map of x-ray, microwave, near-ultraviolet, and visible light emissions from a high-voltage discharge in a long air gap

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Revealing of the sources of high-energy and microwave radiation in laboratory and natural lightning discharges is of great fundamental and applied interest. It is believed that the essential role in generating x-ray and microwave emissions belongs to the streamer collision processes accompanied by complex wave subprocesses in the streamer channels. However, the temporal relationship between the characteristics of the mentioned emissions, depending on the discharge morphology, is still not well studied. This fact challenges the elaboration of consistent models used to describe the mechanisms of the discharge emissions in the x-ray and microwave ranges. On the example of a laboratory discharge initiated in a long air gap by a microsecond megavolt pulse, we better characterize the correlation between various emissions (in x-ray, near-ultraviolet, visible light, and microwave ranges) of the discharge and the development of its morphology. We show that the appearance of an initial cathode corona and propagating streamers coincides with the instant the intense near-ultraviolet emission starts. The intense x-ray and microwave emissions are observed within the discharge stage when the head-on collisions of numerous counter-streamers prevail. Hard x-rays are registered even after a complex system of the developed plasma formations fills the entire discharge gap. Intense visible light emission is detected only after the gap breakdown.

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