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C3Or2B-01 [Invited]: Impact characteristics of liquid nitrogen droplets

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In spray cooling liquid drops impact the hot wall and depending on the wall temperature the drop either touches-down (contact boiling) or levitates (film boiling). The latter case results in a great reduction in heat transfer by the insulating vapour layer under the drop. Here, we study this phenomena for cryogenic systems, where we investigate the impact of a liquid nitrogen droplet on a sapphire plate. Since sapphire is transparent, we can perform high-speed frustrated total internal reflection to study the solid-liquid contact. From our experiments we obtained a phase diagram where the boiling behaviour is characterized by varying the initial prism temperature and drop velocity. Next, we utilized a stream of drops to cool down the prism from the film boiling regime down to the contact boiling regime, where we find good agreement between the heat transfer rate and the contact dynamics as predicted by our phase diagram. Our study gives insight on how the current literature established for non-cryogenic conditions can be applied to the present case of liquid nitrogen drops.

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