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## Cosmic particle acceleration by shocks and turbulence in merging galaxy clusters

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# **Cosmic particle acceleration by shocks and turbulence in merging galaxy clusters**

Duy N. Hoang

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Cover: (Background) A wide-field radio image of the Sausage cluster as observed with the Low Frequency Array (LOFAR) with High-Band Antenna operating at frequency of 143 MHz with a bandwidth of 64 MHz. (Foreground): An enlarged LOFAR radio image of the Sausage cluster on top of a Chandra X-ray image.

# **Cosmic particle acceleration by shocks and turbulence in merging galaxy clusters**

Proefschrift

ter verkrijging van  
de graad van Doctor aan de Universiteit Leiden,  
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volgens besluit van het College voor Promoties  
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Duy N. Hoang

geboren te Vietnam  
in 1981

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For my parents!



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