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## **Towards an ab-axis giant proximity effect using ionic liquid gating**

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### **Citation**

Atesci, H. (2018, September 12). *Towards an ab-axis giant proximity effect using ionic liquid gating*. *Casimir PhD Series*. Retrieved from <https://hdl.handle.net/1887/65452>

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**Issue Date:** 2018-09-12

# Stellingen

*Behorend bij het proefschrift*

*"Towards an ab-axis giant proximity effect using ionic liquid gating"*

- I. Every material should be gateable with ionic liquids, provided  
1) an Ohmic contact can be made with the material, and 2)  
the ionic liquid has a sufficiently large electrochemical potential  
which incorporates the band alignment of the metal-insulator  
junction after the Ohmic contact is present.  
*Chapter 4 of this Thesis.*
- II. The time delay of surface charging, as solely determined by the  
resistivity of the ionic liquid, breaks down for increasing channel  
lengths due to the finite resistivity of the surface conducting  
channel.  
*Chapter 4 of this Thesis.*
- III. A fully electrostatic mechanism of gating in  $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$  should  
be achievable by deposition of an inert layer of  $\text{LaSrAlO}_4$  cover-  
ing the  $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ . This should prevent the (de)oxygation  
of the cuprate during gating.  
*Chapter 6 of this Thesis.*
- IV. As an alternative to ionic liquid gating, it should be possible to  
make a continuous in-plane Josephson junction non-destructively  
through (de)oxygation at elevated temperatures.  
*Chapters 7 and 8 of this Thesis.*
- V. The model proposed by Tsuchiya *et al.* for a gradual spreading  
of conductance over the surface of the insulator can be tested by  
investigating the length dependence of the switching time.  
*Chapter 4 of this Thesis.*  
*T. Tsuchiya et al., ACS Appl. Mater. Interfaces 7, 12254-12260  
(2015).*
- VI. From deviations in the scaling of the gate current one may con-  
clude that the superconductivity found in  $\text{SrTiO}_3$  by Ueno *et al.*  
is (partially) induced by electrochemistry.  
*K. Ueno et al., Nat. Mater. 7, 855-858 (2008).*  
*K. Ueno et al., Appl. Phys. Lett. 96, 252107 (2010).*

- VII. As shown by Nakano *et al.*, when VO<sub>2</sub> (an *n*-type semiconductor) is ionic liquid gated at a temperature above its metal-to-insulator transition temperature, the resistivity of the material increases with increasing gate voltage. Contrary to what is claimed by the authors, the opposite relationship should be expected in case of electrostatic gating.  
*M. Nakano et al., Nature 487, 459-462 (2012).*
- VIII. Suda *et al.* showed the possibility of UV-assisted polarizability of spiropyran monolayers. This polarizability can be used as a viable alternative to ionic liquid gating for the manufacturing of Josephson junctions.  
*M. Suda et al., Science 347, 743-746 (2015).*
- IX. It should be possible to modulate the  $T_c$  of nanopillars of an *a*-axis grown superconductor YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7</sub> by means of an atomic force microscope with a narrow tip.

Hasan Ateşçi,  
Leiden, 12<sup>th</sup> of September 2018