



FACULTAD DE CIENCIAS

**Search for dark matter production in
association with top quarks in the
dilepton final state at $\sqrt{s} = 13$ TeV**

A THESIS SUBMITTED IN FULFILMENT OF THE
REQUIREMENTS FOR THE

Degree of Doctor of Philosophy

Written by
Cédric Prieëls

Under the supervision of
Jónatan Piedra Gómez
Pablo Martínez Ruiz del Árbol

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Bibliography

- [1] M. BORN, P. JORDAN & W. HEISENBERG, *Zur Quantenmechanik. II.*, Physik, 1926
<http://link.springer.com/article/10.1007%2FBF01379806>