



The Abdus Salam
**International Centre
for Theoretical Physics**



**International Conference on Multi-Condensate Superconductivity and
Superfluidity in Solids and Ultra-Cold Gases
14 - 18 May 2018 (Trieste, Italy)**

**Bound Vortex States and Exotic Lattices in Multi-Component Bose-Einstein
Condensates: The role of Vortex-Vortex Interaction**

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Abstract:

We numerically study the vortex-vortex interaction in multi-component homogeneous Bose-Einstein condensates within the realm of the Gross-Pitaevskii theory. We provide strong evidences that pairwise vortex interaction captures the underlying mechanisms which determine the geometric configuration of the vortices, such as different lattices in many-vortex states, as well as the bound vortex states with two (dimer) or three (trimer) vortices. Specifically, we discuss and apply our theoretical approach to investigate intra- and inter-component vortex-vortex interactions in two- and three-component Bose-Einstein condensates, thereby shedding light on the formation of the exotic vortex configurations. These results correlate with current experimental efforts in multi-component Bose-Einstein condensates, and the understanding of the role of vortex interactions in multiband superconductors.