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Off diagonal long range order in solid 4He

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The presence both of long range order (LRO) and of off diagonal long range order (ODLRO) in solid 4He is discussed on the basis of an accurate variational theory (shadow wave function, SWF) and of an exact projection method (shadow path integral ground state, SPIGS). If the solid is incommensurate (e.g. solid with a vacancy: number of atoms different from number of equilibrium sites) both SWF and SPIGS give ODLRO and close to melting density there is a BEC of about 0.3 He atoms per vacancy. For a commensurate solid (number of atoms equal to number of sites) SWF gives ODLRO with a condensate of about one part per thousand. Preliminary evidence indicates that also SPIGS gives a finite BEC. The key process is the spontaneous formation of unbound vacancy-interstitial pairs. These results support the presence of supersolidity in bulk solid 4He. As a final point we address the question if the exact ground state of bulk solid 4He is commensurate or incommensurate and conclude that there is not yet a definite answer to this question from microscopic theory.