World Academy of Science, Engineering and Technology
International Journal of Physical and Mathematical Sciences
Vol:10, No:05, 2016

Physical Theory for One-Dimensional Correlated Electron Systems

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Abstract : The behavior of interacting electrons in one dimension was studied by calculating correlation functions and critical exponents at zero and external magnetic fields for arbitrary band filling. The technique employed in this study is based on the conformal field theory (CFT). The charge and spin degrees of freedom are separated, and described by two independent conformal theories. A detailed comparison of the t-J model with the repulsive Hubbard model was then undertaken with emphasis on their Tomonaga-Luttinger (TL) liquid properties. Near half-filling the exponents of the t-J model take the values of the strong-correlation limit of the Hubbard model, and in the low-density limit the exponents are those of a non-interacting system. The critical exponents obtained in this study belong to the repulsive TL liquid (conducting phase) and attractive TL liquid (superconducting phase). The theoretical results from this study find applications in one-dimensional organic conductors (TTF-TCNQ), organic superconductors (Bechgaard salts) and carbon nanotubes (SWCNTs, DWCNTs and MWCNTs). For instance, the critical exponent at from this study is consistent with the experimental result from optical and photoemission evidence of TL liquid in one-dimensional metallic Bechgaard salt- (TMTSF)2PF6.

Keywords : critical exponents, conformal field theory, Hubbard model, t-J model
Conference Title : ICEMP 2016 : International Conference on Engineering Mathematics and Physics
Conference Location : Rome, Italy
Conference Dates : May 02-03, 2016