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Quantized Berry phase and entanglement entropy for a spin ladder system ISAO MARUYAMA, Osaka university, SHOU TANAYA, MITSUHIRO ARIKAWA, YASUHIRO HATSUGAI, University of Tsukuba — We have demonstrated that quantized Berry phases and entanglement can be used as a new tool for exploring gapped systems which do not exhibit symmetry breaking. Especially, using quantized Berry phases in several gapped systems we identified location of singlet pairs successfully, which illustrate the valence bond solid (VBS)[1], the itinerant singlet [2], the Kondo singlet. Recently, we have studied four-spin ring exchange interaction in a spin-1/2 two-leg ladder, which introduces frustration and generates various phases, such as the dominant vector-chirality (DVC) phase. In the DVC phase, the Berry phase detects the plaquette singlet[3] while entanglement entropy shows that degree of freedom of the edge state is non-zero. It means that singlets are localized at every links and separated as a free spin by adopting the boundary as in the VBS phase. In fact, under the open boundary condition, we found S=1 threefold degenerated excited states with the small gap depends on the system-size as in the Kennedy triplet. [1] T.Hirano, H.Katsura, Y.Hatsugai, PRB 77 (2008) 094431 [2] I.Maruyama, Y.Hatsugai, JPSJ 76 (2007) 113601 [3] I.Maruyama, T.Hirano, Y.Hatsugai, AX.0806.4416

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