

# On Hamilton cycle decompositions of complete multipartite graphs which are both cyclic and symmetric

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A Hamilton cycle of a graph  $G$  with  $v$  vertices is a collection of edges which create a cycle using every vertex. A Hamilton cycle decomposition is cyclic if the set of cycle is invariant under a full length permutation of the vertex set. We say a decomposition is symmetric if all the cycle are invariant under an appropriate power of the full length permutation. Such decompositions are known to exist for complete graphs and families of other graphs. In this work, we show the existence of cyclic  $n$ -symmetric Hamilton cycle decompositions of a family of graphs, the complete multipartite graph  $K_{m \times n}$  where the number of parts,  $m$ , is odd and the part size,  $n$ , is also odd. We classify the existence where  $m$  is prime and prove the existence in additional cases where  $m$  is a composite odd integer.