On 2-arc-transitive and edge-primitive graphs

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A graph is edge-primitive if its automorphism group acts primitively on the edge set. The interests for edge-primitive graphs arises partially from the fact that many (almost) simple groups may be represented as the automorphism groups of edge-primitive graphs. Consulting the Atlas of Finite Groups, one may get first-hand such examples. For example, the sporadic Higman-Sims group HS is the automorphism group of a rank 3 graph with order 100 and valency 22, which is in fact a 2-arc-transitive and edge-primitive graph; the sporadic Rudvalis group Ru is the automorphism group of a rank 3 graph with order 4060 and valency 2304, which is edge-primitive but not 2-arc-transitive. Besides, the almost groups PSU(3,5).2, M22.2, J2.2 and McL.2 all have representations on edge-primitive graphs. In this talk, we focus on those edge-primitive graphs which are 2-arc-transitive. We have an impression from the known examples for edge-primitive graphs in the literature that a 2-arc-transitive and edge-primitive graph has almost simple automorphism group unless it is a cycle or a complete bipartite graph. Yet could it be so? Yes, it is true! We also present a classification result for the 2-arc-transitive graphs with maximal and soluble edge-stabilizers.