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On generalized Melvin solutions for Lie algebras of rank 4

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We consider generalized Melvin-like solutions associated with Lie algebras of rank 4 (namely, A_4, B_4, C_4, D_4, and the exceptional algebra F_4} corresponding to certain internal symmetries of the solutions. The system under consideration is a static cylindrically-symmetric gravitational configuration in D dimensions in presence of four Abelian 2-forms and four scalar fields. The solution is governed by four moduli functions $H_s(z)$ ($s = 1, ..., 4$) of squared radial coordinate $z = \rho^2$ obeying four differential equations of the Toda chain type. These functions turn out to be polynomials of powers $(n_1, n_2, n_3, n_4) = (4, 6, 6, 4), (8, 14, 18, 10), (7, 12, 15, 16), (6, 10, 6, 6), (22, 42, 30, 16)$ for Lie algebras A_4, B_4, C_4, D_4, F_4, respectively. The asymptotic behaviour for the polynomials at large distances is governed by some integer-valued 4×4 matrix ν connected in a certain way with the inverse Cartan matrix of the Lie algebra and (in A_4 case) the matrix representing a generator of the Z_2-group of symmetry of the Dynkin diagram. The symmetry properties and duality identities for polynomials are obtained, as well as asymptotic relations for solutions at large distances. We also calculate 2-form flux integrals over 2-dimensional discs and corresponding Wilson loop factors over their boundaries.

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