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On generalized Melvin solutions for Lie algebras of rank 3

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Generalized Melvin solutions for rank-3 Lie algebras A_3, B_3 and C_3 are considered. Any solution contains metric, three Abelian 2-forms and three scalar fields. It is governed by three moduli functions $H_1(z), H_2(z), H_3(z)$ ($z = \rho^2$ and ρ is a radial variable), obeying three differential equations with certain boundary conditions imposed. These functions are polynomials with powers $(n_1, n_2, n_3) = (3, 4, 3), (6, 10, 6), (5, 8, 9)$ for Lie algebras A_3, B_3, C_3, respectively. The solutions depend upon integration constants $q_1, q_2, q_3 \neq 0$. The power-law asymptotic relations for polynomials at large z are governed by integer-valued 3×3 matrix ν, which coincides with twice the inverse Cartan matrix $2A^{-1}$ for Lie algebras B_3 and C_3, while in the A_3 case $\nu = A^{-1}(I + P)$, where I is the identity matrix and P is a permutation matrix, corresponding to a generator of the $\mathbb{Z}_2$-group of symmetry of the Dynkin diagram. The duality identities for polynomials and asymptotic relations for solutions at large distances are obtained. 2-form flux integrals over a 2-dimensional disc of radius R and corresponding Wilson loop factors over a circle of radius R are presented.

Primary author(s) : Dr. BOLOKHOV, Sergei; Dr. IVASHCHUK, Vladimir

Presenter(s) : Dr. IVASHCHUK, Vladimir

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