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Systems with Discrete Singular ϕ-Laplacian

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We are concerned with solvability of a nonlinear potential system involving a discrete singular ϕ-Laplacian operator, of type

$$-\Delta\left[\phi(\Delta u(n-1))\right] = \nabla_u F(n, u(n)) \qquad (n \in \{1, \dots, T\})$$

associated with a general two point boundary condition having the form

$$(\phi(\Delta u(0)), -\phi(\Delta u(T))) \in \partial j(u(0), u(T+1)),$$

where $j : \mathbb{R}^N \times \mathbb{R}^N \to (-\infty, +\infty]$ is a convex, lower semicontinuous function with $0_{\mathbb{R}^N \times \mathbb{R}^N} \in \partial j(0_{\mathbb{R}^N \times \mathbb{R}^N})$. The mapping ϕ is a potential homeomorphism from an open ball of radius a centered at the origin B_a onto $\mathbb{R}^N$ and Δ is the usual forward difference operator. The prototype of such a ϕ-Laplacian is the *discrete relativistic operator*, corresponding to $\phi(y) = y/\sqrt{1-|y|^2}$, $y \in B_1$. The potential $F(n, \cdot)$ is assumed to be of class C^1, for all $n \in \{1, \dots, T\}$. We provide a variational approach of the problem in the frame of critical point theory for convex, lower semicontinuous perturbations of C^1-functionals. Then we derive the existence of solutions either as minimizers or saddle points of the corresponding energy functional. This talk is based on joint work with Petru Jebelean and Călin Şerban [1],[2].

References

[1] A. Gruie and C. Şerban, Non-homogeneous discrete Dirichlet problem with singular ϕ-Laplacian, *Appl. Math. Lett.* **176** (2026), 109859.

[2] A. Gruie, P. Jebelean and C. Şerban, Systems with discrete singular ϕ-Laplacian and maximal monotone boundary conditions, *submitted*.

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