Mathematical Physics

The Role of Symmetry and Separation in Surface Evolution and Curve Shortening

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(Submitted on 1 Jun 2011)

With few exceptions, known explicit solutions of the curve shortening flow (CSE) of a plane curve, can be constructed by classical Lie point symmetry reductions or by functional separation of variables. One of the functionally separated solutions is the exact curve shortening flow of a closed, convex "oval"-shaped curve and another is the smoothing of an initial periodic curve that is close to a square wave. The types of anisotropic evaporation coefficient are found for which the evaporation-condensation evolution does or does not have solutions that are analogous to the basic solutions of the CSE, namely the grim reaper travelling wave, the homothetic shrinking closed curve and the homothetically expanding grain boundary groove. Using equivalence classes of anisotropic diffusion equations, it is shown that physical models of evaporation-condensation must have a diffusivity function that decreases as the inverse square of large slope. Some exact separated solutions are constructed for physically consistent anisotropic diffusion equations.

Subjects:	**Mathematical Physics (math-ph)**; Analysis of PDEs (math.AP); Exactly Solvable and Integrable Systems (nlin.SI)
Journal reference:	SIGMA 7 (2011), 052, 19 pages
DOI:	10.3842/SIGMA.2011.052
Cite as:	**arXiv:1106.0092 [math-ph]**
	(or **arXiv:1106.0092v1 [math-ph]** for this version)

Submission history

From: Sigma [view email]

[v1] Wed, 1 Jun 2011 05:01:17 GMT (187kb)

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