

Accepted Manuscript

Unconditionally stable methods for gradient flow using Convex Splitting Runge–Kutta scheme

Jaemin Shin, Hyun Geun Lee, June-Yub Lee

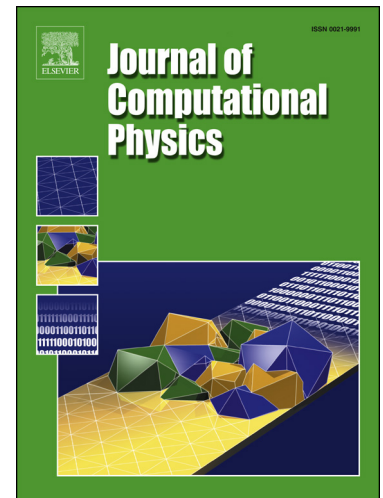
PII: S0021-9991(17)30508-9
DOI: <http://dx.doi.org/10.1016/j.jcp.2017.07.006>
Reference: YJCPH 7453

To appear in: *Journal of Computational Physics*

Received date: 3 November 2016
Revised date: 30 June 2017
Accepted date: 3 July 2017

Please cite this article in press as: J. Shin et al., Unconditionally stable methods for gradient flow using Convex Splitting Runge–Kutta scheme, *J. Comput. Phys.* (2017), <http://dx.doi.org/10.1016/j.jcp.2017.07.006>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



Unconditionally stable methods for gradient flow using Convex Splitting Runge–Kutta scheme

Jaemin Shin ^a, Hyun Geun Lee ^b, June-Yub Lee ^{c,*}

^a*Institute of Mathematical Sciences, Ewha Womans University, Seoul 03760, Korea*

^b*Department of Mathematics, Kwangwoon University, Seoul 01897, Korea*

^c*Department of Mathematics, Ewha Womans University, Seoul 03760, Korea*

Abstract

We propose a Convex Splitting Runge–Kutta (CSRK) scheme which provides a simple unified framework to solve a gradient flow in an unconditionally gradient stable manner. The key feature of the scheme is a combination of a convex splitting method and a specially designed multi-stage two-additive Runge–Kutta method. Our methods are high order accurate in time and assure the gradient (energy) stability for any time step size. We provide detailed proof of the unconditional energy stability and present issues on the practical implementations. We demonstrate the accuracy and stability of the proposed methods using numerical experiments of the Cahn–Hilliard equation.

Key words: Gradient flow, Convex splitting, Gradient stability, Energy stability, Phase-field model, Cahn–Hilliard equation

1 Introduction

Gradient systems have been fundamental in the development of many important concepts in dynamical systems [1]. In particular, gradient systems are important in many phenomenological models of phase transition such as the Allen–Cahn and Cahn–Hilliard equations [2, 3]. We concentrate on a numerical method for solving the initial value problem, which can be represented as

* Corresponding author

Email address: jy1lee@ewha.ac.kr (June-Yub Lee).

Download English Version:

<https://daneshyari.com/en/article/4967148>

Download Persian Version:

<https://daneshyari.com/article/4967148>

[Daneshyari.com](https://daneshyari.com)