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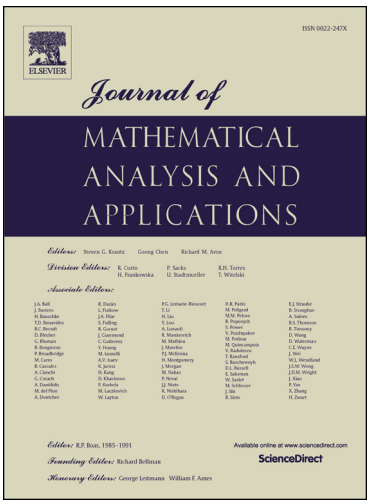

On external fields created by fixed charges

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On external fields created by fixed charges

R. Orive[1,*], J. F. Sánchez Lara[2]

Abstract

In this paper equilibrium measures in the presence of external fields created by fixed charges are analyzed. These external fields are a particular case of the so-called rational external fields (in the sense that their derivatives are rational functions). Along with some general results, a thorough analysis of the particular case of two fixed negative charges ("attractors") is presented; indeed, the main result of the paper deals with this particular case. As for the main tools used, this paper is a natural continuation of [33], where polynomial external fields were thoroughly studied, and [39], where rational external fields with a polynomial part were considered. However, the absence of the polynomial part in the external fields analyzed in the current paper adds a considerable difficulty to solve the problem and justifies its separated treatment; moreover, it is noteworthy to point out the simplicity and beauty of the results obtained.

Keywords and phrases: Equilibrium measures, External fields, Phase transitions.

1. Introduction

This paper is devoted to the study of equilibrium measures in the real axis in the presence of rational external fields created by fixed charges. These are external fields of the form:

$$\varphi(x) = \sum_{j=1}^{q} \gamma_j \, \log |x - z_j| \, , \; \gamma_j \in \mathbb{R} \, , \; z_j \in \mathbb{C} \, , \tag{1}$$

where for $\gamma_k > 0$, z_k must lie on $\mathbb{C} \setminus \mathbb{R}$, and it is assumed that $\displaystyle\sum_{j=1}^{q} \gamma_j = T > 0$. These conditions ensure that given any $t \in (0, T)$, there exists a measure $\lambda_t = \lambda_{t,\varphi}$, such that $\lambda_t(\mathbb{R}) = t$, with compact support $S_t \subset \mathbb{R}$, uniquely determined by the equilibrium condition (see e.g. [41])

$$V^{\lambda_t}(x) + \varphi(x) \begin{cases} = c_t \, , & x \in S_t \, , \\ \geq c_t \, , & x \in \mathbb{R} \, , \end{cases} \tag{2}$$

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