

The CMV bispectral problem

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Abstract

A classical result due to Bochner classifies the orthogonal polynomials on the real line which are common eigenfunctions of a second order linear differential operator. We settle a natural version of the Bochner problem on the unit circle which answers a similar question concerning orthogonal Laurent polynomials and can be formulated as a bispectral problem involving CMV matrices. We solve this CMV bispectral problem in great generality proving that, except the Lebesgue measure, no other one on the unit circle yields a sequence of orthogonal Laurent polynomials which are eigenfunctions of a linear differential operator of arbitrary order. Actually, we prove that this is the case even if such an eigenfunction condition is imposed up to finitely many orthogonal Laurent polynomials.

Keywords and phrases: bispectral problems, differential operators, CMV matrices, orthogonal Laurent polynomials, measures on the unit circle

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1 Introduction

The motivation for the problem we address here can be traced to work in signal processing started by C. Shannon [39]. Addressing his problem required finding and exploiting some remarkable mathematical miracles and was accomplished in a series of papers by three workers at Bell Labs in the 1960's: David Slepian, Henry Landau and Henry Pollak, see [32, 33, 42–46]. The most important of these miracles is the existence of a second order *differential operator* that commutes with Shannon's time-and-band limiting *integral operator*.

In an effort to understand and extend the range of applicability of these miracles one of us introduced the so called “bispectral problem”, see [5]. For connections of this notion with the “time-and-band limiting problem” of Shannon see for instance

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