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## ACCEPTED MANUSCRIPT

### Reproducing pairs and Gabor systems at critical density

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#### Abstract

We use the concept of reproducing pairs to study Gabor systems at critical density. First, we present a generalization of the Balian-Low theorem to the reproducing pairs setting. Then, we prove our main result that there exists a reproducing partner for the Gabor system of integer time-frequency shifts of the Gaussian. In other words, the coefficients for this Gabor expansion of a square integrable function can be calculated using inner products with an unstructured family of vectors in  $L^2(\mathbb{R})$ . This solves one of the last few open questions for this system.

#### *MSC2010:* 42C15; 42C40

*Keywords:* Gabor systems; reproducing pairs; critical density; Zak transform; Balian-Low theorem

#### 1. Introduction

The main problem of Gabor analysis is to understand the conditions and obstructions on the family  $G(g, \Lambda) := \{T_{\lambda_1} M_{\lambda_2} g\}_{\lambda \in \Lambda} \subset L^2(\mathbb{R})$  to be a frame. There exists, however, a great abundance of windows g and lattices  $\Lambda$  generating Gabor families which are, on the one hand, complete and, on the other hand, violate at least one of the frame bounds. The well-known Balian-Low theorem, for example, states that the window function of a Gabor frame at the

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