



# **APPLIED MATHEMATICS and INFORMATICS**

**European Conference for the APPLIED MATHEMATICS and  
INFORMATICS**

**Vouliagmeni, Athens, Greece  
December 29-31, 2010**

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## Plenary Lecture 1

### Density and Approximation by Radial Basis Functions



**Professor Vitaly Maiorov**

**Abstract:** We characterize the radial basis functions whose scattered shifts form a fundamental system in the space  $L_p(\mathbb{R}^d)$ . In particular, we show that for any even function  $h$  from the space  $L_2(\mathbb{R}, \mu)$ , the space formed by all possible linear combinations of shifted radial functions  $h(\|x + a\|)$ ,  $a \in \mathbb{R}^d$ , is dense in the space  $L_p(\mathbb{R}^d)$ ,  $1 \leq p \leq 2$ , if and only if the function  $h$  is not a polynomial. The problems of approximation by radial basis functions also are discussed.

In order to obtain our results we make use of methods of harmonic analysis on the unit ball  $B^d$  which are based on a combination of methods of harmonic analysis on the unit sphere  $\mathbb{S}^{d-1}$  and the unit segment  $\mathbf{U} := [-1, 1]$ . Using an orthogonal basis of spherical harmonics on  $\mathbb{S}^{d-1}$  and the Gegenbauer basis of orthogonal polynomials on the segment  $\mathbf{U}$  we construct a new basis  $\mathbf{P} = \{P_n\}$  ('convolution' of bases on  $\mathbb{S}^{d-1}$  and on  $\mathbf{U}$ ) consisting of orthogonal polynomials on the ball  $B^d$ . The peculiarity of the basis  $\mathbf{P}$  is that the moments  $M_\alpha(g, a) := \langle g_a, P_n \rangle$  of radial functions of the form  $g_a = g(\|x + a\|)$  in some sense allow for a separation of the variables  $g$  and  $a$ . That is, we represent them by the finite sum  $M_\alpha(g, a) = \sum_k u_k(g)v_k(a)$ , where  $u_k(g)$  are a linear functionals of  $g$  and  $v_k(a)$  are a functions on  $\mathbb{R}^d$ .

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