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Let  $f = a_0x^n + na_1x^{n-1}y + \cdots + a_ny^n$  be a binary form over a field  $k$  of characteristic zero. To such a form we associate a standard action of  $SL_2$  on the polynomial ring  $k[a_0, \dots, a_n, x, y]$ . An element  $g$  of  $k[a_0, \dots, a_n, x, y]^{SL_2}$  is called an apolar covariant if the  $n$ -th transvectant  $(f, g)_n = 0$ .

This talk is directed to the issue of the determination of the apolar covariants. We will explore this question from the perspectives of representation theory, combinatorics, and determination of polynomial solutions of partial differential equations. The consequences of the existence of apolar covariants will be explored with particular reference to the problems of construction of invariants and determination of the finiteness of SAGBI for rings of invariants and covariants. (Received September 26, 2006)