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Counting strings over the integers mod a power of two with given elementary symmetric function evaluations

Let α be a string over $\mathbb{Z}_q$, where $q = 2^d$. The j-th elementary symmetric function evaluated at α is denoted $e_j(\alpha)$. We study the cardinalities $S_q(m\ ;\ \tau_1, \tau_2, \ldots, \tau_t)$ of the set of length m strings for which $e_i(\alpha) = \tau_i$. The *profile* $\mathbf{k}(\alpha) = \langle k_1, k_2, \ldots, k_{q-1}\rangle$ of a string α is the sequence of frequencies with which each letter occurs. The profile of α determines $e_j(\alpha)$, and hence S_q. Let $h_n\colon \mathbb{Z}_{2^{n+d-1}}^{(q-1)} \mapsto \mathbb{Z}_{2^d}[z] \bmod z^{2^n}$ be the map that takes $\mathbf{k}(\alpha) \bmod 2^{n+d-1}$ to the polynomial $1 + e_1(\alpha)z + e_2(\alpha)z^2 + \cdots + e_{2^n-1}(\alpha)z^{2^n-1}$. We show that h_n is a group homomorphism and establish necessary conditions for membership in the kernel for fixed d. The kernel is determined for $d = 2, 3$. The range of h_n is described for $d = 2$. These results are used to "efficiently" compute $S_4(m\ ; \tau_1, \tau_2, \ldots, \tau_t)$.

This is joint research with Bob Miers at UVic.