A generalization of the Silvester-Kac matrix

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Abstract: Recently [2], C. da Fonseca et al considered a model for deposition and evaporation on discrete cells of a finite array of any dimension that led to a matrix equation involving a Sylvester-Kac type matrix. They found the eigenvalues and eigenvectors of that matrix and generalized some results of R. Askey [1] and O. Holtz [3]. In this talk, we discuss a somewhat novel approach that allows to generalize the results of all previous authors. More exactly, we find the eigenvalues and eigenvectors of the following $N \times N$ matrix:

$$\begin{pmatrix} 0 & \alpha & 0 & \dots & 0 & 0 & 0 \\ -N\gamma & \beta & 2\alpha & \dots & 0 & 0 & 0 \\ 0 & -(N-1)\gamma & 2\beta & \dots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \dots & (N-2)\beta & (N-1)\alpha & 0 \\ 0 & 0 & 0 & \dots & -2\gamma & (N-1)\beta & N\alpha \\ 0 & 0 & 0 & \dots & 0 & -\gamma & N\beta \end{pmatrix},$$

where α, β, and γ are arbitrary complex numbers, and $\gamma \neq 0$.

[1] R. Askey, Evaluation of Sylvester type determinants using orthogonal polynomials, in: H.G.W. Begehr, et al. (Eds.), Advances in Analysis, World Scientific, Hackensack, NJ, 2005, pp. 1–16.

[2] C. da Fonseca, D. Mazilu, I. Mazilu, T. Williams, The eigenpairs of a Sylvester-Kac type matrix associated with a simple model for one-dimensional deposition and evaporation, Appl. Math. Lett., 26, no. 12, pp. 1206–1211.

[3] O. Holtz, Evaluation of Sylvester type determinants using block-triangularization, in: H.G.W. Begehr, et al. (Eds.), Advances in Analysis, World Scientific, Hackensack, NJ, 2005, pp. 395–405.