1154-47-220 **J. William Helton**, **Igor Klep**, **Scott McCullough** and **Jurij Volčič*** (volcic@math.tamu.edu). *Noncommutative polynomials describing convex sets.*

The free semialgebraic set $\mathcal{D}_f$ determined by a hermitian noncommutative polynomial $f \in M_d(\mathbb{C}\langle x, x^*\rangle)$ is the closure of the connected component of $\{X\colon f(X,X^*) \succ 0\}$ containing the origin. When L is a hermitian monic linear pencil, the free semialgebraic set $\mathcal{D}_L$ is called a free spectrahedron. Since it is the feasible set of a linear matrix inequality (LMI), it is evidently convex. Conversely, it is well-known that every convex free semialgebraic set is a free spectrahedron. This talk presents a solution to the basic problem of determining those f for which $\mathcal{D}_f$ is convex. A consequence is an effective probabilistic algorithm that not only determines if $\mathcal{D}_f$ is convex, but if so, produces its LMI representation. Of independent interest is a subalgorithm based on a Nichtsingulärstellensatz: given a linear pencil L and a free spectrahedron $\mathcal{D}$, it determines if L takes only invertible values on the interior of $\mathcal{D}$. Lastly, if $\mathcal{D}_f$ is convex and $f \in \mathbb{C}\langle x, x^*\rangle$ is irreducible, then f is quadratic. (Received August 24, 2019)