1106-16-162 **Hongbo Li***, AMSS, Chinese Academy of Sciences, Zhong Guan Cun E. Rd. 55, Haidian Dist., Beijing, 100190, Peoples Rep of China, and **Lei Huang**, **Yue Liu**, **Shoubin Yao**, **Ge Li** and **Changpeng Shao**. *Syzygies for the basis-free definition of quaternionic or Clifford polynomial ring.*

A (generalized) quaternion over a field $\mathbb{K}$ of char $\neq 2$ is $\mathbf{q} = u + x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$, where $u, x, y, z \in \mathbb{K}$, and $1, \mathbf{i}, \mathbf{j}, \mathbf{k}$ are the basis of quaternions. All quaternions form a non-commutative ring $\mathbb{Q}_{\mathbb{K}}$. In a quaternionic variable $\mathbf{q}$, the coefficients u, x, y, z are variables in $\mathbb{K}$. The polynomial ring $\mathbb{Q}_{\mathbb{K}}[u_\alpha, x_\alpha, y_\alpha, z_\alpha \,|\, \alpha = 1, 2, \ldots, m]$ contains a subring generated by the $\mathbf{q}_\alpha = u_\alpha + x_\alpha\mathbf{i} + y_\alpha\mathbf{j} + z_\alpha\mathbf{k}$ and the conjugate $\bar{\mathbf{q}}_\alpha = u_\alpha - x_\alpha\mathbf{i} - y_\alpha\mathbf{j} - z_\alpha\mathbf{k}$. The subring is called the quaternionic polynomial ring.

Owning to the quaternionic representation of 3-D rotations, basis-free manipulations of quaternionic polynomials has important applications in 3-D geometric deduction. In this talk we introduce our recent work on defining the basis-free quaternionic polynomial ring as the quotient of the free associative algebra generated by the $\mathbf{q}_\alpha, \bar{\mathbf{q}}_\alpha$ modulo an ideal of syzygies, the proof of the equivalence with the original definition, and the generalization to Clifford polynomial ring over 3-D inner-product space. (Received August 02, 2014)