

Moment Angle Complexes and Integral Cohomology of Toric Orbifolds

Tomoo Matsumura

KAIST, joint with Shisen Luo, Frank Moore

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Remark: $\text{Tor}_0^{\mathbb{Z}[R^*]}(\mathbb{Z}[K], \mathbb{Z}) = \mathbb{Z}[K]/\langle u_1, \dots, u_n \rangle$.

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Fact: [Danilov, Jurkiewicz, Davis-Januszkiewicz, Poddar-Sarkar, Holm-M]

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Eg. $[\mathbb{C}\mathbb{P}_{a_1 \dots a_m}^{m-1}]$ satisfies (\star) over \mathbb{Z} but the direct product of them doesn't.

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Fact. If \mathcal{X} is a compact "toric orbifold" of $\dim_{\mathbb{R}} = 2n$ with action of torus $\mathbb{R}^{(n)}$, we can find a simplicial complex K and $B \in \text{Mat}_{n,m}(\mathbb{Z})$ such that

$$\mathbb{R} \curvearrowright \mathcal{X} = [\mathcal{Z}_K/G] \quad \text{where } G := \ker(B : \mathbb{T} \rightarrow \mathbb{R}).$$

Defn. $H^*([\mathcal{Z}_K/G]; \mathbb{Z}) := H_G^*(\mathcal{Z}_K; \mathbb{Z})$ and $H_R^*([\mathcal{Z}_K/G]; \mathbb{Z}) := H_T^*(\mathcal{Z}_K; \mathbb{Z})$.

Fact: [Danilov, Jurkiewicz, Davis-Januszkiewicz, Poddar-Sarkar, Holm-M]

$$H_{\mathbb{R}}^*(\mathcal{X}; \mathbb{Z}) = \frac{\mathbb{Z}[x_1, \dots, x_m]}{\langle x_{i_1} \cdots x_{i_r}, \{i_1, \dots, i_r\} \notin K \rangle} =: \mathbb{Z}[K] \quad \text{Stanley-Reisner Ring.}$$

$$(\star) \quad H^*(\mathcal{X}; \mathbb{Q}) = \frac{\mathbb{Q}[K]}{\langle u_1, \dots, u_n \rangle} \quad u_i := \sum_{j=1}^m B_{ij} x_j.$$

It holds over \mathbb{Z} if \mathcal{X} is smooth.

Question: What happens if we work over \mathbb{Z} in general ??

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Eg (non-bCM). $H^*([\mathbb{C}P_a^{m-1}] \times [\mathbb{C}P_a^{m-1}])$ has \mathbb{Z} -torsion in odd degree by Künneth formula.

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Question Can we compute $H_G^*(\mathcal{Z}_K)$ in terms of $H_G^*(\mathcal{Z}_{K_{\pm}})$ and $H_G(\mathcal{Z}_W)$??

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Thm. Suppose that $(\mathcal{P}_+, \mathcal{P}_-)$ is a cut of \mathcal{P} .

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Let K_+ and K_- be simplicial complexes on $[m]$ (may have ghost vertices).

Let $Z \subset W := K_+ \cap K_-$ s.t. $O_{K_+ \cup K_-}(Z) \subset W$. (Suppose K_{\pm}, W are pure.)

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Cutting polytopes: Let: $\mathcal{P} \subset \mathbb{R}^n$ a simple polytope, $\mathcal{X}_{\mathcal{P}} = [\mathcal{Z}_{K_{\mathcal{P}}}/G]$ a toric orbifold. "Cut" \mathcal{P} into \mathcal{P}_+ and \mathcal{P}_- , then $\mathcal{X}_{\mathcal{P}}$ is an equivariant connected sum of $\mathcal{X}_{\mathcal{P}_+}$ and $\mathcal{X}_{\mathcal{P}_-}$ along $\mathcal{X}_{\mathcal{P}_+ \cap \mathcal{P}_-}$.

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