

Projectivity of good moduli spaces of quiver representations

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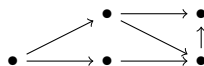
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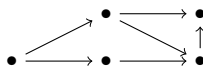
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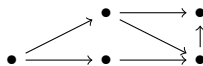
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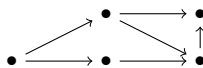
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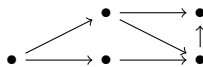
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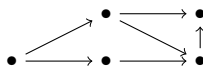
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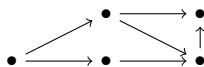
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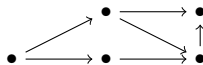
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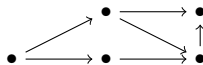
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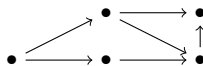
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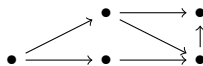
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Goal: $\mathcal{M}_d^{\theta\text{-ss}}$ has a projective good moduli space.

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$$\begin{array}{ccc} \Theta_R \setminus 0 & \hookrightarrow & \Theta_R \\ & \searrow & \downarrow \exists! \\ & & \mathcal{X} \end{array}$$

Dashed arrow must exist for any R and any solid arrow.

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Ample determinantal line bundle

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3. Bonus 1: any $m > |\lambda| \cdot \|d\|^2$ works, where λ is smallest eigenvalue of $(A + A^T)/2$ and A is the matrix of $\chi(_, _)$

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- **Thm** (BDFHMT):

1. For every θ -ss M there is $m > 0$ and N with $\mathbf{d}(N) = m\beta$ s.t. $\text{Hom}(M, N) = 0$

$\Rightarrow \sigma_N$'s give a map $f : M_d^{\theta\text{-ss}} \rightarrow \mathbb{P}^n$

2. For polystable M_1 and M_2 with a distinct stable factor, can choose N s.t. $\text{Hom}(M_1, N) = 0$ but $\text{Hom}(M_2, N) \neq 0$
 $\Rightarrow f$ is finite, so $M_d^{\theta\text{-ss}}$ is projective

3. Bonus 1: any $m > |\lambda| \cdot \|d\|^2$ works, where λ is smallest eigenvalue of $(A + A^T)/2$ and A is the matrix of $\chi(_, _)$

4. Bonus 2: can use sections σ_N to find étale local quotient presentations for $\mathcal{M}_d^{\theta\text{-ss}}$ over any field k or even $\mathbb{Z} \Rightarrow \mathcal{M}_d^{\theta\text{-ss}}$ has an adequate moduli space

- Is $M_d^{\theta\text{-ss}}$ projective?

[King, 1994] Yes: $\mathcal{M}_d \cong \left[\prod_a \mathbb{A}^{d_s(a)} / \prod_i \text{GL}(d_i) \right]$,
GIT-stability = θ -stability

- Need an ample line bundle on $M_d^{\theta\text{-ss}}$.

$\mathcal{M}_d^{\theta\text{-ss}}$ param. universal family \mathcal{F} . Define

$$\mathcal{L}_\theta = \bigotimes_{i \in Q_0} \det(\mathcal{F}_i)^{\otimes -\theta_i} \in \text{Pic}(\mathcal{M}_d^{\theta\text{-ss}})$$

\mathcal{L}_θ descends to $L_\theta \in \text{Pic}(M_d^{\theta\text{-ss}})$

- Sections of $\mathcal{L}_\theta/L_\theta$ from representations:

Can write $\theta(_) = -\chi(_, \beta)$ where $\beta \in \mathbb{N}^{Q_0}$

Given rep N with $\mathbf{d}(N) = m\beta$, get complex

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- Hom-vanishing via dimension count à la Esteves-Popa for vector bundles on a curve
- Preservation of semistability under *Auslander-Reiten duality* – analogue of Serre duality