Module Isogeny Key Exchange : MIKE for high-schoolers

Andrea Basso, Pierrick Dartois, Max Duparc, Jonathan Komada Eriksen, Sabrina Kunzweiler, Michael Meyer, Giacomo Pope, Krijn Reijnders, Damien Robert, Ryan Rueger and Sina Schaeffler

2026, May 12

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- The tensor product functor should satisfy natural properties:

$$\begin{array}{ccc} (M \otimes 1) \otimes M' & \xrightarrow{a_{M,1,M'}} & M \otimes (1 \otimes M') \\ & {\scriptstyle \rho_M \otimes 1_{M'}} \searrow \quad \swarrow {\scriptstyle 1_M \otimes \rho_{M'}} & \\ & M \otimes M' & \end{array}$$

where $M, M', M'', M''' \in \mathscr{M}$ and the arrows are obvious isomorphisms.

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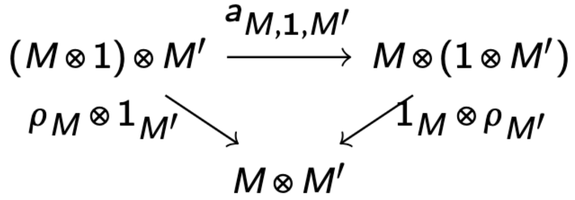

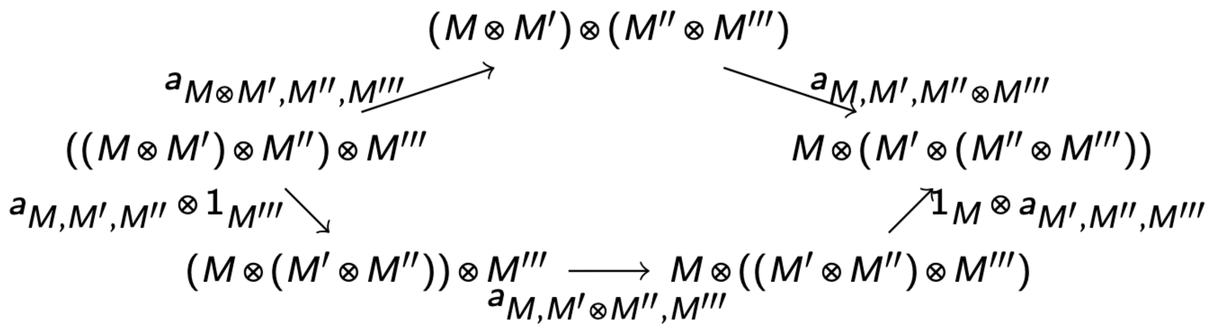

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$$\begin{array}{ccccc} (M \otimes M') \otimes M'' & \xrightarrow{a_{M,M',M''}} & M \otimes (M' \otimes M'') & \xrightarrow{B_{M,M' \otimes M''}} & (M' \otimes M'') \otimes M \\ \downarrow {\scriptstyle B_{M,M'} \otimes 1_{M''}} & & & & {\scriptstyle a_{M',M'',M}} \downarrow \\ (M' \otimes M) \otimes M'' & \xrightarrow[a_{M',M,M''}]{} & M' \otimes (M \otimes M'') & \xrightarrow[1_{M'} \otimes B_{M,M''}]{} & M' \otimes (M'' \otimes M) \end{array}$$

$$\begin{array}{ccccc} & & (M \otimes M') \otimes (M'' \otimes M''') & & \\ & {\scriptstyle a_{M \otimes M',M'',M'''}} \nearrow & & \searrow {\scriptstyle a_{M,M',M'' \otimes M'''}} & \\ ((M \otimes M') \otimes M'') \otimes M''' & & & & M \otimes (M' \otimes (M'' \otimes M''')) \\ {\scriptstyle a_{M,M',M''} \otimes 1_{M'''}} \searrow & & & & \nearrow {\scriptstyle 1_M \otimes a_{M',M'',M'''}} \\ & (M \otimes (M' \otimes M'')) \otimes M''' & \xrightarrow[a_{M,M' \otimes M'',M'''}]{} & M \otimes ((M' \otimes M'') \otimes M''') & \end{array}$$

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1

Everybody says isogenies are slow

Lattice people tryin’ to get in my head

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Abstract mathematics are my own heart talkin'

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I need to count core cycles instead

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(Did you ever) hear of abelian categories ?

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Did you ever need a NIKE, well you can count on MIKE

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Let’s look again for: a simple NIKE (Simple NIKE)

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Post-quantum, small and fast, that all is MIKE (all is MIKE)

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We wanna make it right, MIKE is the way

We wanna make it right, MIKE is the way

Only 64 bytes, believe what we say,

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How will we know if it's a path worth takin' ?

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That it won't be too easy to break ?

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Since SIKE was lost, there is no more fakin'

How will we know if it's a path worth takin’ ?

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We don't wanna make the same mistakes

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(Did you ever) Have your dreams all broken with SIKE?

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(Did you ever) Blame the maths, and fear their next strike?

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(We will never) count on torsion points again

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We won’t play this game again, our tools are different

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Instantiating a symmetric monoidal action

- Let $\mathscr{M}$ be a symmetric monoidal category and $\mathscr{C}$ be another category.
- A **symmetric monoidal action** is a functor $\mathscr{M} \times \mathscr{C} \to \mathscr{C}$ which respects the obvious coherence conditions.
- It can also be seen as a strong monoidal functor $\mathscr{M} \to \mathrm{End}(\mathscr{C})$.
- We can instantiate a symmetric monoidal action with the **power construction**. If $M \in \mathscr{M}$ and $C \in \mathscr{C}$, the **power object** $\mathscr{HOM}_{\mathscr{M}}(M, C) \in \mathscr{C}$ (if it exists) is the unique object satisfying the universal property:

$$\mathrm{Hom}_{\mathscr{C}}(C', \mathscr{HOM}_{\mathscr{M}}(M, C)) = \mathrm{Hom}_{\mathscr{C}}(M, \mathrm{Hom}_{\mathscr{C}}(C', C)),$$

  for all $C' \in \mathscr{C}$.
- **Trivial example:** for any commutative ring R, the action of finitely presented R-modules on R-oriented commutative proper group schemes. The construction is left as an exercise.

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IS BELIEVE

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- Tiny public keys: 64B
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Anaëlle Le Dévéhat
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