

# Composite explanations

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- ▶ Lower level explains behaviour higher level (reduction assumption)
- ▶ Higher level allows for concise descriptions of complex behaviour

# Syntax

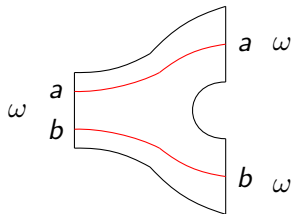
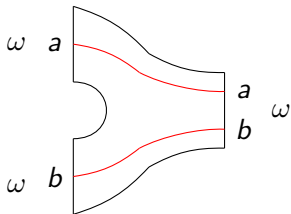
$$\frac{\sigma \in \Sigma \setminus \Sigma^i}{\sigma : (\text{ar}(\sigma) \mid \text{coar}(\sigma))} \quad \frac{\sigma \in \Sigma^i}{\omega \alpha \boxed{\sigma} \alpha \omega : (\text{ar}(\sigma) \mid \text{coar}(\sigma))}$$

$$\frac{}{\boxed{\phantom{\sigma}} : (\varepsilon \mid \varepsilon)} \quad \frac{}{\omega \alpha \boxed{\phantom{\sigma}} \alpha \omega : (\omega, \alpha \mid \omega, \alpha)}$$

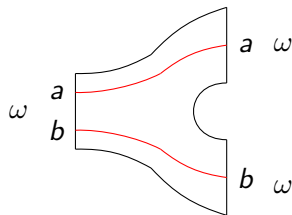
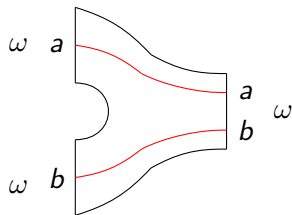
$$\frac{\omega \alpha \begin{array}{c} \diagup \quad \diagdown \\ \diagdown \quad \diagup \end{array} \alpha \tau : (\omega, \alpha; \tau, \beta \mid \tau, \beta; \omega, \alpha)}{\tau \beta \begin{array}{c} \diagup \quad \diagdown \\ \diagdown \quad \diagup \end{array} \beta \omega} \quad \frac{x : (t \mid s) \quad y : (s \mid u)}{x; y : (t, u)}$$

$$\frac{x : (\omega, \alpha \mid \omega, \gamma) \quad y : (\omega, \beta \mid \omega, \delta)}{x \oplus_{\omega} y : (\omega, \alpha \beta \mid \omega, \gamma \delta)} \quad \frac{x : (t \mid s) \quad y : (u \mid w)}{x \oplus y : (t; u \mid s; w)}$$

## Syntax 2



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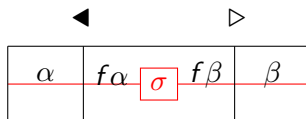
$$\omega \quad \begin{array}{|c|c|} \hline \alpha & f\alpha \\ \hline & \\ \hline \end{array} \quad \tau$$


$$\tau \quad \begin{array}{|c|c|} \hline f\alpha & \alpha \\ \hline & \\ \hline \end{array} \quad \omega$$

# Explanations

## Definition (Window, cwindow)

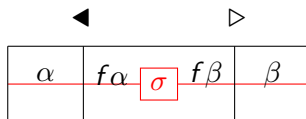
A *window* is a morphism in a layered prop of the following form:



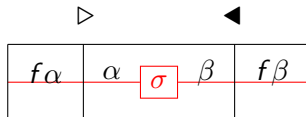
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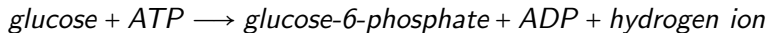
Dually, a *cwindow* is a morphism in a layered prop of the following form:



# Example: glucose phosphorylation

after Jean Krivine

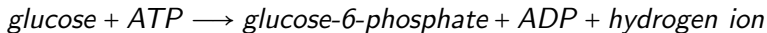
We wish to explain the chemical reaction rule:



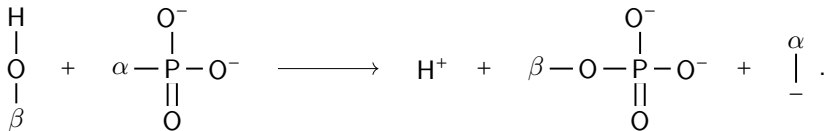
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We wish to explain the chemical reaction rule:



using the interaction between parts of molecules:

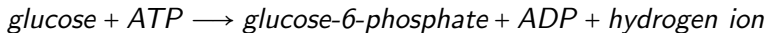




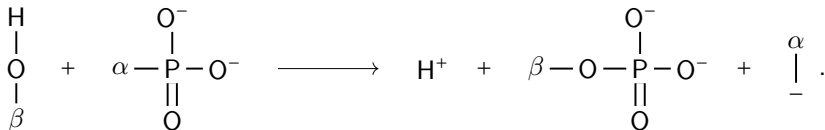
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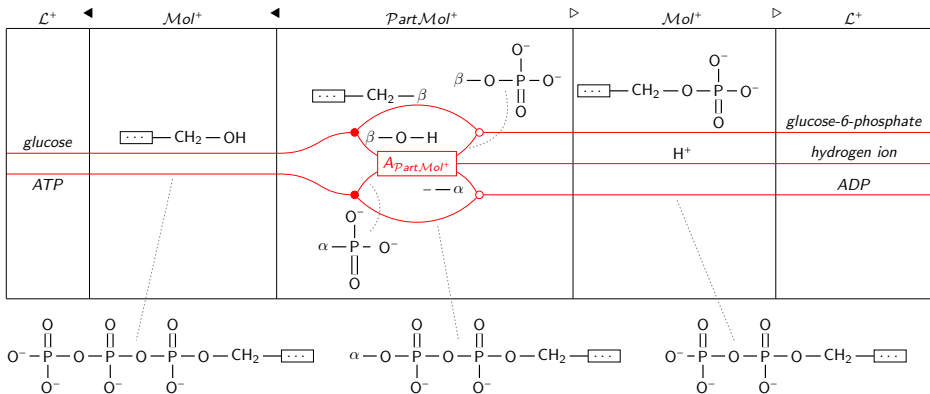
We draw this as an internal box:



in the layered prop.

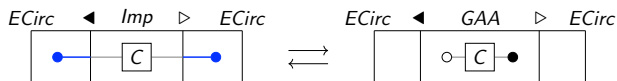
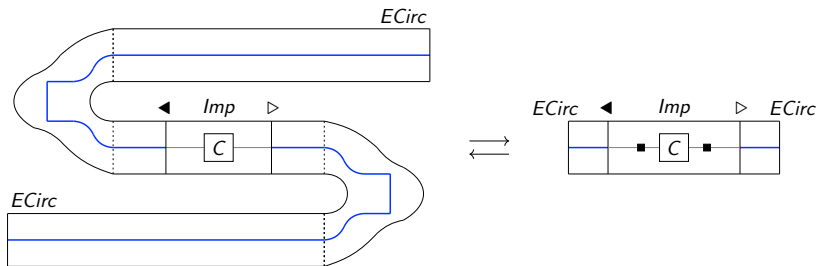
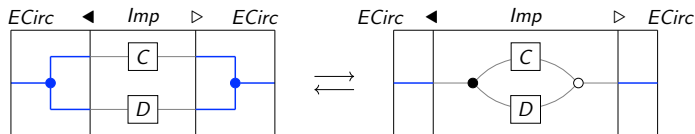
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# Example: electrical circuits

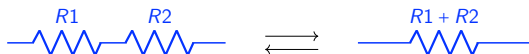
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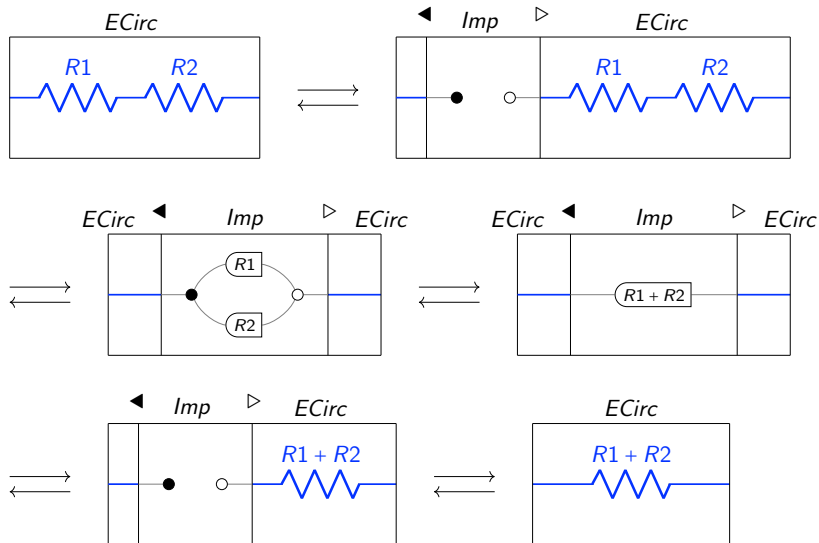
after Boisseau and Sobociński

We wish to explain the rule for the sequential composition of resistors:



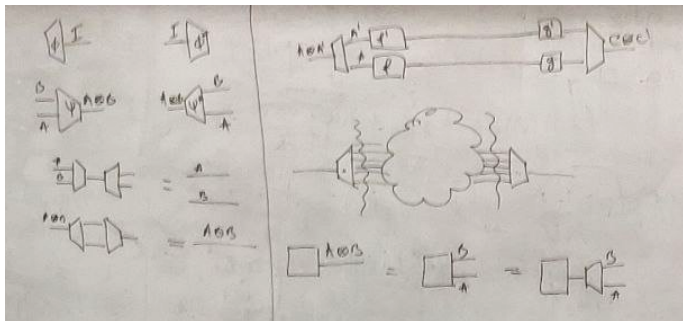
# Example: electrical circuits

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# Example?? Strictification of monoidal categories

after Dan Ghica



# References

- ▶ Bruce Bartlett, Christopher L. Douglas, Christopher J. Schommer-Pries, and Jamie Vicary. *Modular categories as representations of the 3-dimensional bordism 2-category*. arXiv:1509.06811.
- ▶ Guillaume Boisseau and Pawel Sobociński. *String Diagrammatic Electrical Circuit Theory*. arXiv:2106.07763v1.
- ▶ Jean Krivine. *Physical systems, composite explanations and diagrams*. SYCO 5 / STRINGS 3 Conference talk, 2019.
- ▶ Jean Krivine. *Systems biology*. ACM SIGLOG News 4.3, 2017.

Thank you for your attention!