



Hvordan bringer vi kvanteteknologi til gymnasiet?

Hvad betyder kvant/quantum?



Det er et buzzword



Hvad underviser I allerede i, der er kvant?

Hvorfor kvanteteknologi nu?



Danish Quantum
Community

novo nordisk
fonden

55North

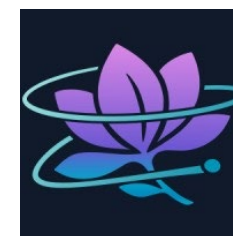


SPARROW
QUANTUM



QUANTUM
FOUNDRY
COPENHAGEN

QuNorth®



NQCP

NIELS BOHR INSTITUTE

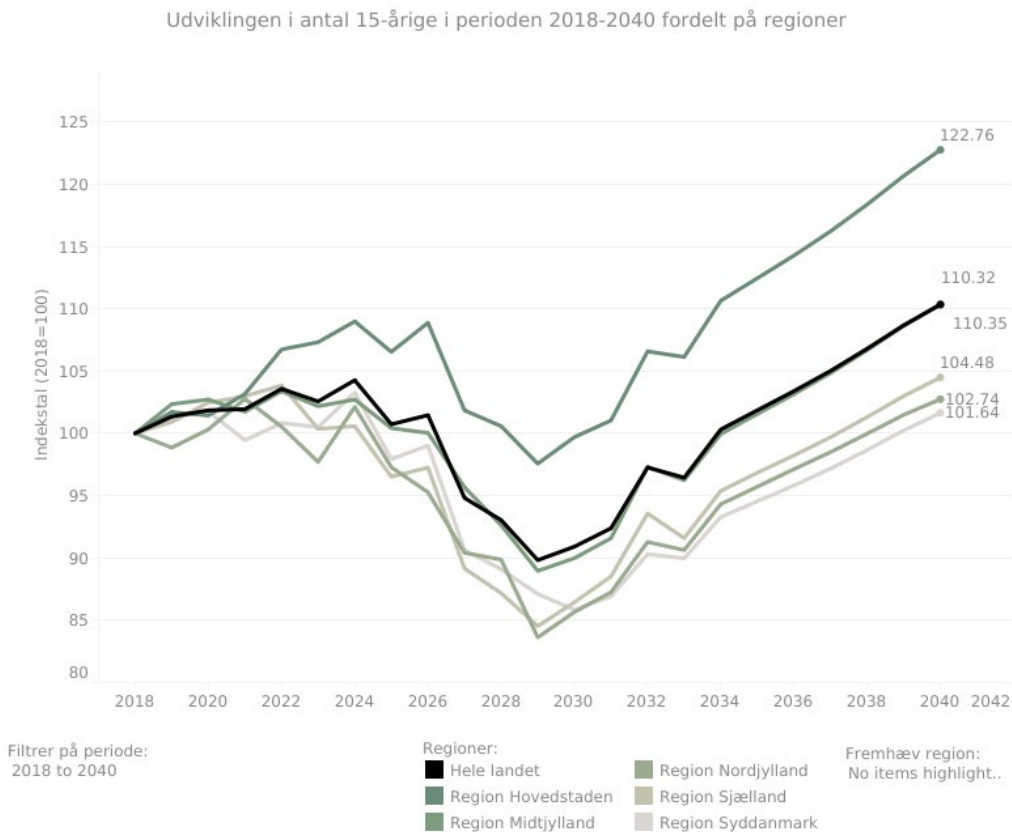


Strategi for
Kvanteteknologi

Del 1 – Forskning og
innovation i verdensklasse

Juni 2023

Det kræver arbejdskraft



Kilde: Danmarks Statistik - Statistikbanken FRLD118

Uddannelse	2020	2021	2022	2023	2024
STX, nat. vid.	8721	8926	8916	8422	7763
STX, samf	10541	11308	11201	11525	11266
STX, sproglig	2391	2506	2189	1885	1936
HHX, øk. og marked	7364	8492	8523	9069	8877
HTX, nat. vid.	2008	2935	2801	2758	2599

Hvad er KVANT21?

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graph TD; Title[Hvad er KVANT21?]; KVANT((KVANT)) --> GreenBox[Undervisningsmaterialer og efteruddannelse til fysik A og senere fysik B om kvanteteknologi]; 21((21)) --> OrangeBox[Det næste emne til fysik i det 21. århundrede (forhåbentlig)];
```

Undervisningsmaterialer og efteruddannelse til fysik A og senere fysik B om kvanteteknologi

SRP-katalog, A-niveau bog, B-niveau bog, eksperimenter, videoer mm.

Læreplaner 2030?

Det næste emne til fysik i det 21. århundrede (forhåbentlig)

Foreløbige tanker:
Kvanteobjekter
Superposition
2-state systemer
Interferometri
Sammenfiltring
Målinger

Hvad bliver KVANT21 ikke?

$$i\hbar \frac{\partial}{\partial t} \psi(x, t) = -\frac{\hbar^2}{2m} \frac{\partial^2 \psi(x, t)}{\partial x^2} + V\psi(x, t)$$

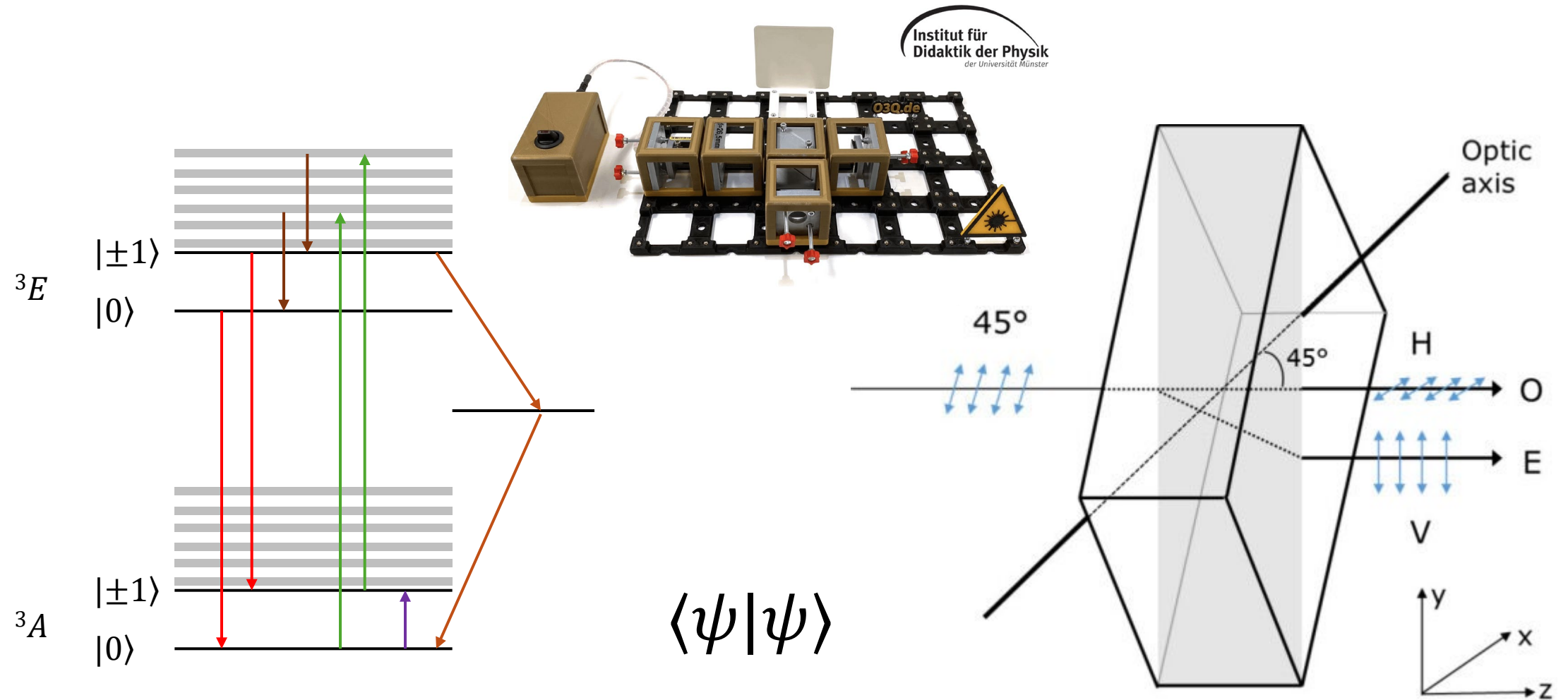


KVANTECOMPUTERENS MATEMATIK

Qubits, entanglement og kvantealgoritmer
3-dages kursus for gymnasielærere
21.-22. sep. 2026 og 13. jan. 2027

$$|\uparrow\rangle |0\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} |\downarrow\rangle |0\rangle \xrightarrow{\text{Hadamard}} \frac{|00\rangle + |11\rangle}{\sqrt{2}} \quad |1\rangle = \begin{pmatrix} 0 \\ 1 \end{pmatrix} \quad |\uparrow\rangle |0\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} |\downarrow\rangle |0\rangle \xrightarrow{\text{Hadamard}} \frac{|00\rangle + |11\rangle}{\sqrt{2}} \quad |1\rangle = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

Hvad kan man så?



Search for the stars

et lille spil fra Canada om Grovers algoritme

Search for the Stars

Instructions

- This activity pits two players/teams against each other to try to find stars as quickly as possible
 - One player will mimic a *classical search*, which can only turn over elements one-by-one. This will be demonstrated by placing a number of tiles face-down and allowing them to turn over one per turn.
 - The other player will mimic a *quantum search*, where the outcome of a measurement is random but other operations are allowed. On each turn, they may either roll a dice to represent a quantum measurement or iterate *Grover's Algorithm*, changing the probability of success on their next turn.
- There are different database sizes, with the quantum player's advantage growing stronger with the size of the database
 - The classical tiles must be shuffled after each round

Search for the Stars

Game setup

- This game is for **two** players (or teams).
- The goal of the game is to be the first to collect 2 stars at each stage.
- Each player searches for stars in a different way:
 - The **Classical Player** searches by turning over cards until they see a star.
 - The **Quantum Player** searches using a quantum machine, with the probability of finding a star changing as they use the machine more.
- At the end of each turn, players turn over an event card, which could affect one or both of them.
 - Once used, the card goes to the Discard pile and is re-shuffled once the last card has been turned over.
 - You may choose to not include event cards for your first game.
- Each stage is a database of a different size, either 4, 12, or 30.
 - When starting a new stage, the classical player must shuffle one star into the specified number of “dot” cards while the quantum player uses dice.
 - The arrow token for the quantum player starts on the left-most tile.
 - The recommended play order is to complete 4, then 12, and finally 30.

Search for the Stars

Turn order

Each turn starts with the classical player, then the quantum player.

- **Classical player:** Turn over one card from your deck.
 - If the card has a star, collect a star token and re-shuffle your entire deck.
- **Quantum Player:** Choose to either iterate **or** measure.
 - **Measure:** Roll the dice that the arrow currently points to.
 - If the roll is a success, collect a star token. If not, do not collect a star token.
 - Regardless of the outcome, move the arrow back to the left-most tile after measuring.
 - If the arrow points to the star tile, you may measure to collect a star without rolling any dice.
 - **Iterate:** Move the arrow one tile to the right.
 - If you move the arrow to the star tile, you must wait for your next turn to collect the star. This counts as a measurement.
- **Event:** Turn over the top event card and follow the instructions.
 - If this is your first game, you may choose to not include Event cards.
 - Events may affect the Classical Player, Quantum Player, or both.

Vil du være med eller vide mere?



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