QuVis Applets in Czech

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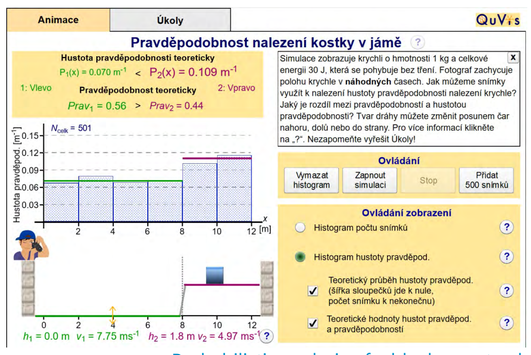
The Quantum Mechanics Visualisation Project

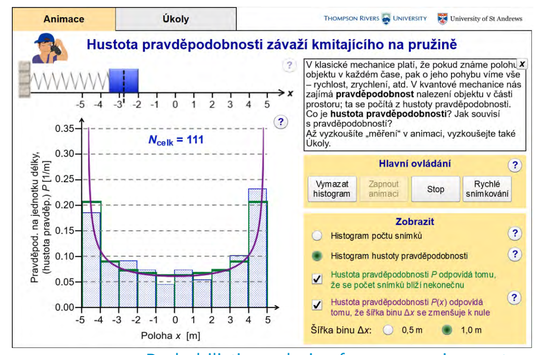
- the QuVis project is led by Antje Kohnle (University of St Andrews)
- a collection of research-based interactive applets
- single purpose applets
- covering advanced high school level to advanced undergraduate university level
- to help students make connections between multiple representations, and explore relationships between quantities

https://www.st-andrews.ac.uk/physics/quvis/

Classical systems

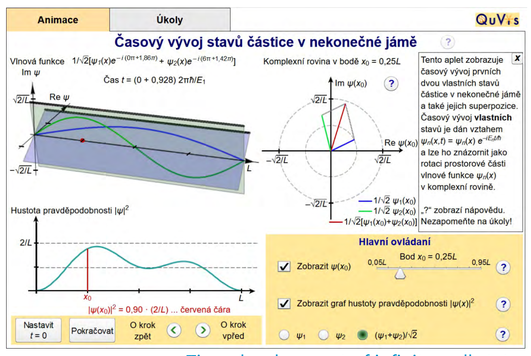


Probabilistic analysis of a block on a track

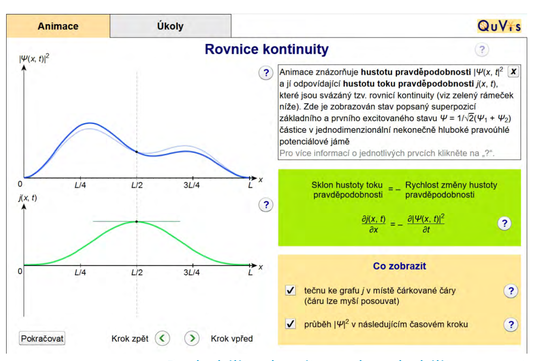


Probabilistic analysis of a mass-spring system

Fundamental concepts

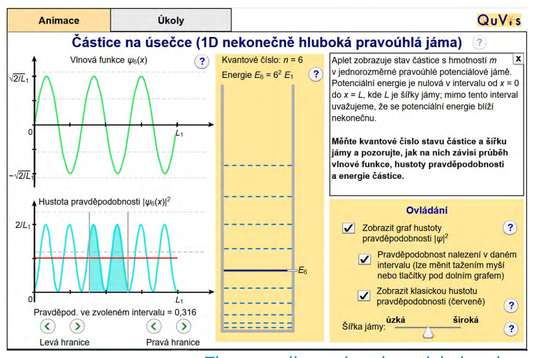


Time development of infinite well states

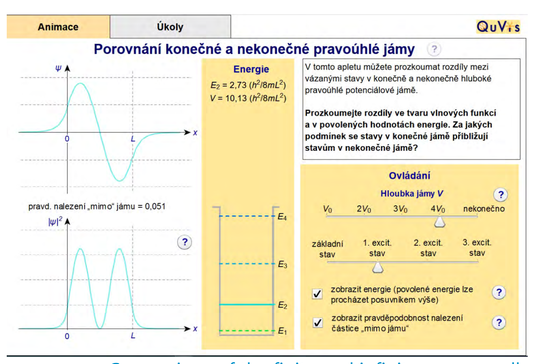


Probability density and probability current

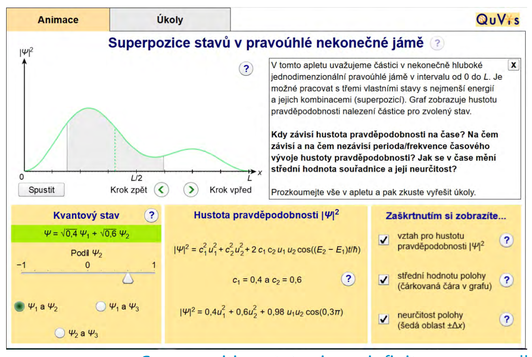
One dimensional potentials



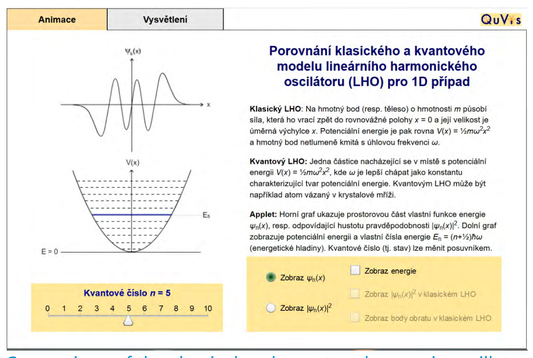
The one-dimensional particle in a box



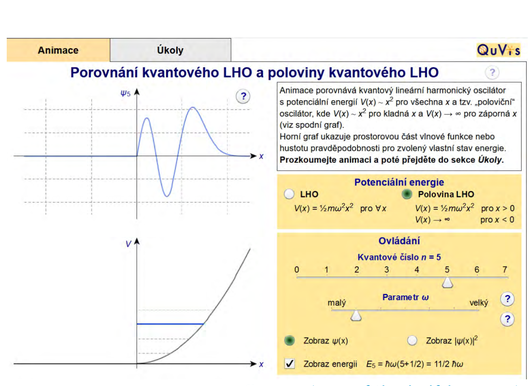
Comparison of the finite and infinite square wells



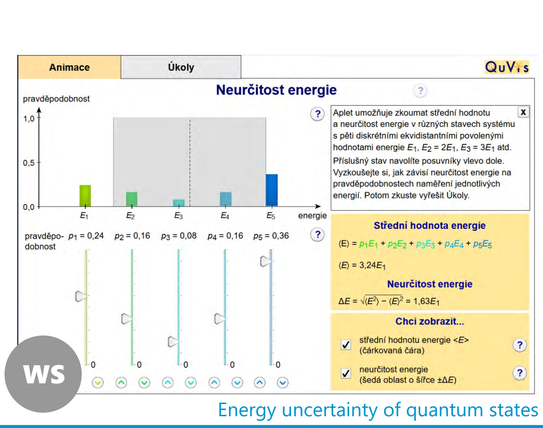
Superposition states in an infinite square well



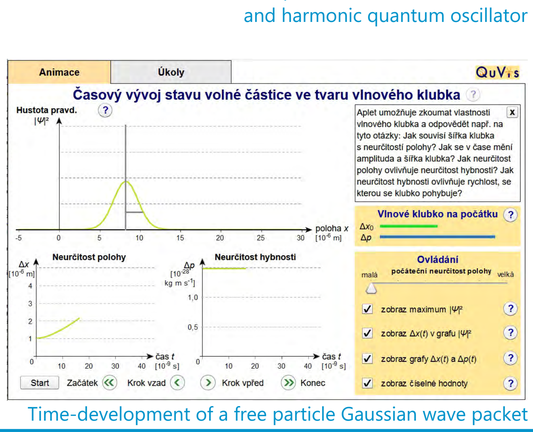
Comparison of the classical and quantum harmonic oscillator



Comparison of the half-harmonic and harmonic quantum oscillator

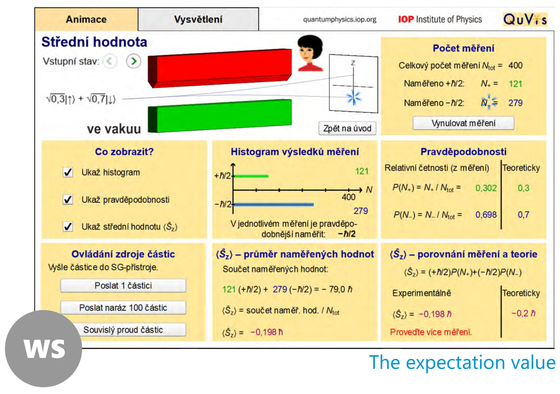


Energy uncertainty of quantum states

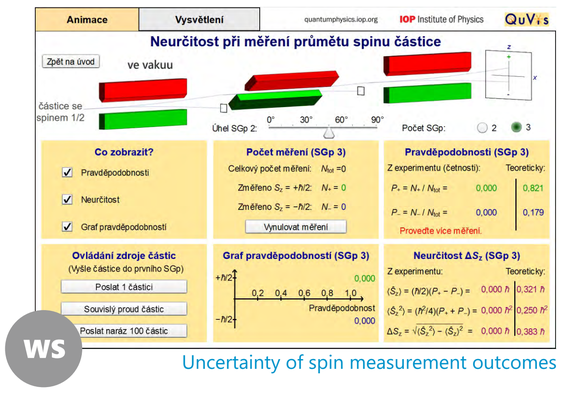


Time-development of a free particle Gaussian wave packet

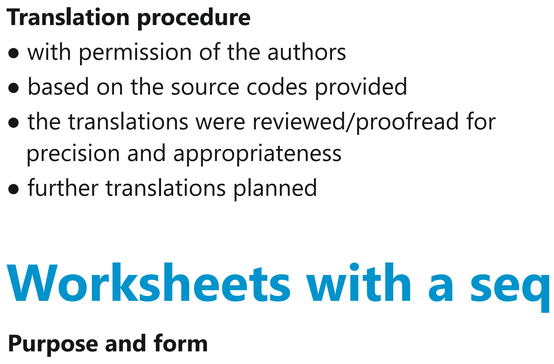
Spin and angular momentum



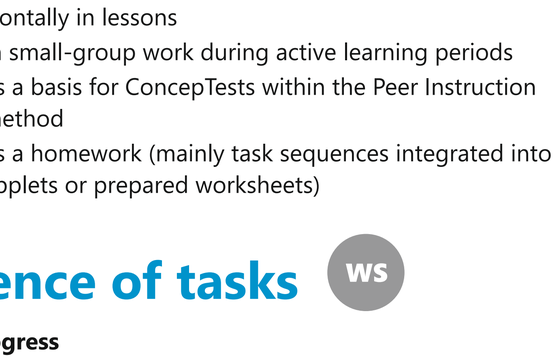
The expectation value



Uncertainty of spin measurement outcomes



Superposition states and mixed states



Spin 1 particles in successive Stern–Gerlach experiments

Translation into Czech

Why to translate QuVis applets?

- focus on concepts rather than mathematical representations → suitable for pre-service teachers' QM courses
- pre-service teachers need to acquire terminology in their native language
- certain applets are appropriate to be used even at secondary school level

Translation procedure

- with permission of the authors
- based on the source codes provided
- the translations were reviewed/proofread for precision and appropriateness
- further translations planned

Availability

- freely available on the web
- certain applets supplemented by student worksheets (see below)

Implementation in an undergraduate pre-service teachers' QM course

- frontally in lessons
- in small-group work during active learning periods
- as a basis for ConcepTests within the Peer Instruction method
- as a homework (mainly task sequences integrated into applets or prepared worksheets)

Worksheets with a sequence of tasks

WS

Purpose and form

- worksheets for undergraduate students
- encouraging students to work independently
- using applets to solve tasks in the worksheets
- based on materials from original applets, but also including new, supplementary tasks (both computational and conceptual)

Progress

- worksheets developed within a bachelor's thesis of Martin Landa, under supervision
- five worksheets prepared, three of them currently translated into English
- 10–18 tasks in every worksheet

References

Kohnle A. et al (2010). *Developing and evaluating animations for teaching quantum mechanics concepts*. Eur. J. Phys. 31 1441

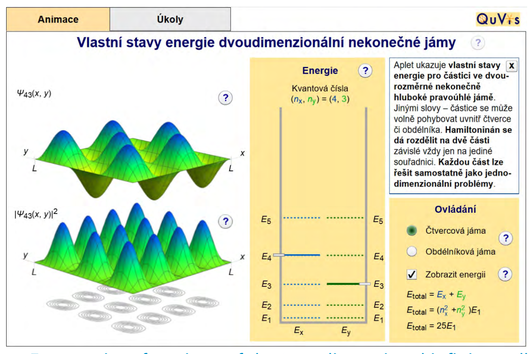
Kohnle A. et al. (2012). *A new multimedia resource for teaching quantum mechanics concepts* Am. J. Phys. 80, 148-153

Landa, M. (2021). *Úlohy pro práci s aplety – axiom o měření v kvantové mechanice*. Bachelor thesis. Charles University, Faculty of Mathematics and Physics. Supervisor Koupilová, Z.

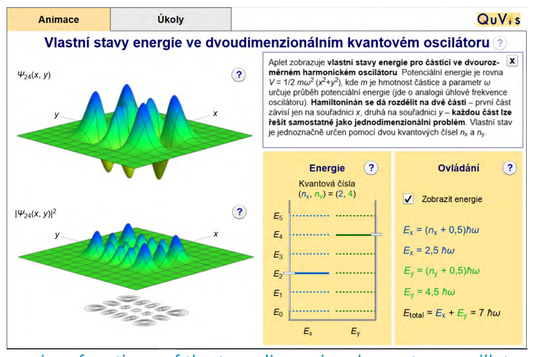
Koupilová Z., & Kácovský P. (2020). *Conceptual Problems and Graphical Representation in Introductory Course of Quantum Physics*. In Džubinská Andrea, Reiffers Marián (editors): 20th Conference of Czech and Slovak Physicists Proceedings, 107-108, Equilibria, s.r.o., Košice

Koupilová, Z., & Kácovský, P. (2022). *Interactive applets in introductory course of quantum physics: Their role not only in distance learning*. In AIP Conference Proceedings (Vol. 2458, No. 1). AIP Publishing.

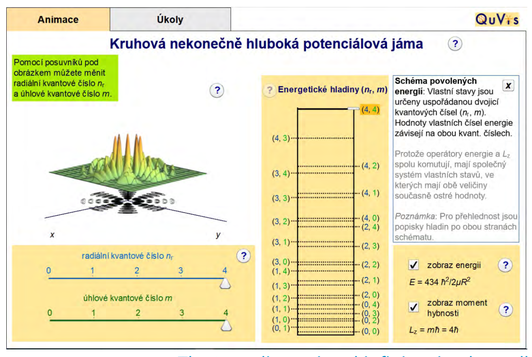
Two dimensional potentials



Energy eigenfunctions of the two-dimensional infinite well

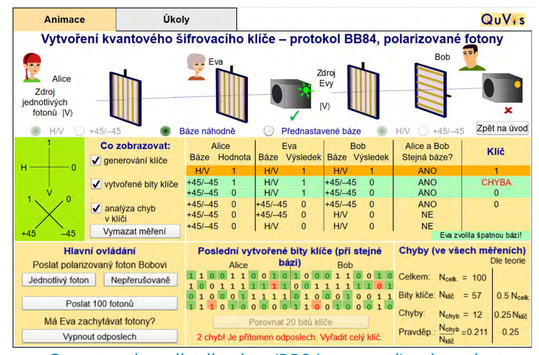


Energy eigenfunctions of the two-dimensional quantum oscillator



The two-dimensional infinite circular well

Quantum information



Quantum key distribution (BB84 protocol) using photons

Two dimensional potentials

Energy eigenfunctions of the two-dimensional quantum oscillator