

BornAgain - Bug #2416

Polarized: Fix treatment of imperfect analyzers

20 Nov 2019 11:45 - dmitry

Status:	Backlog	Start date:	20 Nov 2019
Priority:	Normal	Due date:	
Assignee:	rbeerwerth	% Done:	0%
Category:		Estimated time:	0.00 hour
Target version:			
Description			
Currently the analyzer operator used in BornAgain is written (in latex notation) as			
$a = t (1 + \xi \sigma p).$			
Here t is the transmission, ξ - efficiency, p - vector of analyzer direction, σ - vector of Pauli matrices. However, only the combination of $t = 1/2$, $\xi = 1$ and $ p = 1$ is meaningful and corresponds to a perfect analyzer (i.e. the one always selecting a particular polarization state).			
According to the section 4 of this internal report (note that login to jugit is required to access the document), the analyzer operator should look like			
$a = \frac{t}{2} (2 - p + \sigma p).$			
Then $ p \leq 1$ corresponds to the efficiency of the analyzer and $0 \leq t \leq 1$ - to the transmission.			
The formula above for sure works for specular reflectivity, but before modifying the code it is necessary to check that it holds true in the case of GISAS. The description of polarized DWBA by Walter Van Herck can provide some insight in how DWBA is applied in BornAgain.			
The analyzer operator is computed in DetectionProperties::analyzerOperator . One will also need to change the signature of the method setAnalyzerProperties in Simulation class, and correspondingly amend polarization-related classes in the GUI.			
Related issues:			
Related to BornAgain - Envelope task #2419: Polarized - summary of tasks		In Progress	
Related to BornAgain - Bug #2356: Parameterization: Undefined state in Instru...		Backlog	13 May 2019

History

#1 - 20 Nov 2019 11:45 - dmitry

- Category set to 5

#2 - 20 Nov 2019 13:57 - dmitry

- Related to Envelope task #2419: Polarized - summary of tasks added

#3 - 20 Nov 2019 14:51 - dmitry

- Description updated

#4 - 20 Nov 2019 14:52 - dmitry

- Related to Bug #2356: Parameterization: Undefined state in Instrument > Polarization analysis > Analyzer orientation and efficiency added

#5 - 29 Jun 2020 10:07 - rbeerwerth

After a first discussion with Artur, he wasn't happy with this operator at all.

He also pointed me to <https://doi.org/10.1063/1.1150060>, this is the standard paper for treating imperfect instruments.

I will study that and rethink this problem. For the moment I leave the implemented operator in BornAgain untouched (NOT the one described in the documents).

Also, we need to pay attention to the case polarized beam + no polarization analysis, this is actually the experimental standard case. This

corresponds to $p = 0$, but we might want to provide it as a default if no analyzer is specified.

#6 - 05 Aug 2020 17:25 - rbeerwerth

After reading and thinking about this, i think that the operator described in the internal report (Polarized Specular Reflectometry) is not correct. I added a small explanation in that document below section 4.1.

I will read up a bit more on theory, but i think the "normal" density matrix for polarization, as given above with the transmission correction, is the correct approach.

It might be a good idea though to give the transmission as < 1 not $< 1/2$, that would be less confusing. Whether we want to include the efficiency as variable and specify the polarization always as unit vector vs. the specification as a polarization vector with possibly non-unit length can be up for discussion. Other means of parameterization consistent with the literature area also thinkable.

#7 - 19 Sep 2020 09:12 - wuttke

- Subject changed from Polarization: Fix treatment of imperfect analyzers to Polarized: Fix treatment of imperfect analyzers

- Assignee set to rbeerwerth