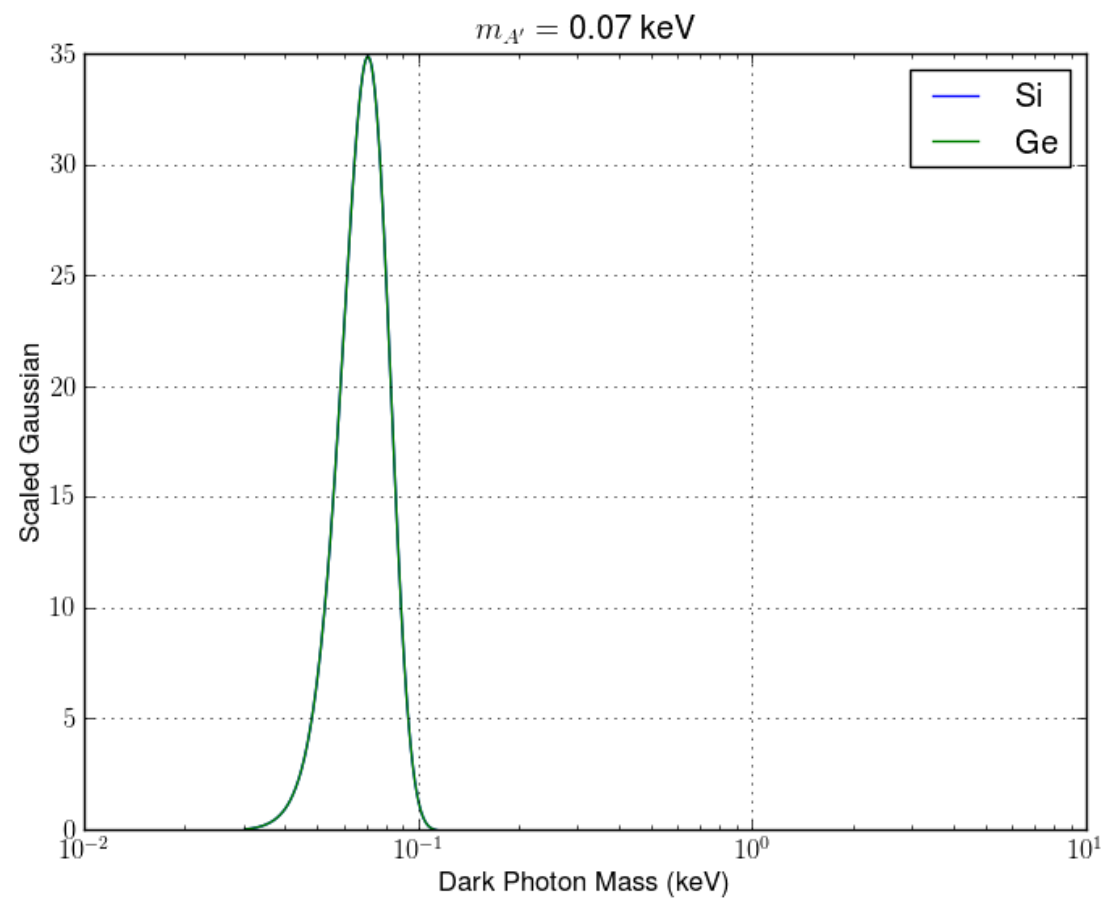
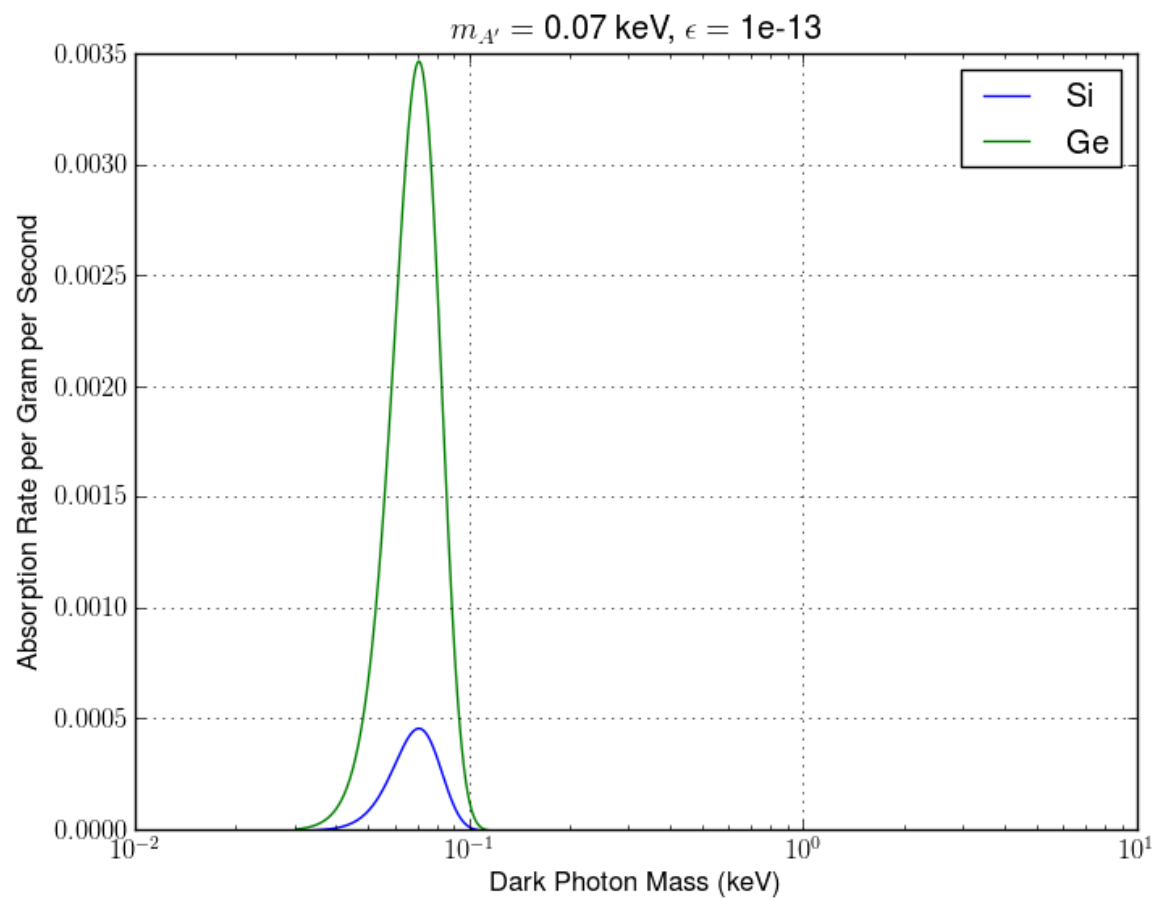


Weekly Meeting

October 25 2017

Dark Photon

- Working on script to generate energy spectra.
- 2 modes:
 - Given a dark photon mass *and* a coupling strength, generate energy spectrum scaled by the expected rate.
 - Given *only* a dark photon mass, generate a normalized energy spectrum, where $\int f(E) dE = 1$. Reasoning: take a measurement, and then want to scale the model to get the best-fit epsilon value.
 - So code can operate both modes. Will soon upload it so Belina can use it for sensitivity analysis.



Dark Photon

Photoelectric absorption cross sections – I've been doing a lot of digging over the past week to obtain any and all experiment data about absorption cross sections.

What I have found I have put into a summary table.

Edit title	Link	Year	Element	State	Measured or calculated Value(s)	Method	Energy Range	Temperature Dependence			
Measurement of the mass attenuation coefficients for SiH ₄ and Si	link	1994	Si	Crystal, ~0.03 cm thick	Mass attenuation, pe cross section	Light intensity	1.4-30 keV	No			
Absolute photoabsorption measurements of Mg, Al, Si in the soft x-ray region below the L _{2,3} edges	link	1994	Si	1.95 μm thick single crystal	Mass attenuation	Light intensity	25-100eV ish	No			
Observation of Absorption Edges in the extreme Ultraviolet by transmittance measurements through thin unbacked metal films	Scanned book	1964	Si, Ge	Evaporation films, unknown thickness	TOTAL linear attenuation	Light intensity	Down to 20eV	No			
Reflectance and total photoelectric yield measurements of silicon wafers in the XUV spectral range	link	1990	Si	Wafer, sub nm thickness	Photoabsorption yeild	Electron collector, reflected beam	50-900eV	No			
Photoelectric cross sections for 6-20 keV photon in beryllium, carbon, magnesium, aluminum, silicon, copper, silver, and lead	link	1988	Si	Foil, in range of 0.01 cm thick	Total cross se., pe cross se.	Light intensity	6-20keV	No			
X-ray attenuation of silicon in the energy range 25-50 keV	link	1985	Si	Crystal, 2-4 mm thick	Total mass attenuation, Total cross se.	Light intensity	25-50keV	No			
X-ray attenuation coefficients and atomic photoelectric absorption cross sections of silicon	link	1981	Si	Crystals, 0.4-4 mm thick	Mass and linear attenuation, photoelectric cross se.	Light intensity	>8 keV	No			
Determination of X-ray photoelectric absorption of Ge and Si avoiding solid-state effects	link	2000	Si, Ge	>100 μm thick samples	Total attenuation, pe attenuation	Light intensity	>8 keV	No			
X-ray linear absorption coefficient of silicon for Cu K _α and Mo K _α radiations	link	1976	Si	0.05 cm thick crystal	Total linear attenuation, total mass attenuation	Light intensity	>8 keV	No			
X-Ray Attenuation in Silicon and Germanium in the Energy Range 25 to 50 keV	link	1977	Si, Ge	>0.15 mm thick	Total linear attenuation	Light intensity	25-50 keV	No			
A Precision Measurement of some Attenuation Coefficients for 1.33 MeV Gamme Rays	link	1975	Si	25mm filter	Total mass attenuation	Light intensity	1.33 MeV	No			
Measurement of totally depleted silicon solid state detector thickness by x-ray attenuation	link	1972	Si	~170μm thick samples	Total mass attenuation (indirectly)	Light intensity	10 keV	No			
Normal and anomalous absorption of X-rays in Germanium and Silicon	link	1973	Si, Ge	Unknown	Pe linear attenuation	Unknown	5-25 keV	Unknown			
Measurements of Gamma-Ray Attenuation Coefficients	link	1972	Si, Ge	Powder, ~1cm thick	Total mass attenuation	Light Intensity	>0.662 MeV	No			
Effect of Compton Scattering on the Borrmann Effect of X-Rays in Silicon Crystals	link	1973	Si	Crystal, >2cm thick	Total linear attenuation, calculated pe linear attenuation	Light intensity	>17 keV	Yes			
Extreme Ultraviolet Transmission of Crystalline and Amorphous Silicon	link	1971	Si	Amorphous films and crystals, 1000-2000 Å	Total linear attenuation	Light intensity	>99 eV	No			
Photoabsorption near the L _{II,III} Edge of Silicon and Aluminum	link	1970	Si	Evaporated films, 200-2500 Å	Total linear attenuation	Light intensity	>95 eV	No			
Measurement of Photo-Absorption Cross Sections in the Energy Region 10-30 MeV with a Magnetic Compton Spectrometer	link	1969	Si	Powder, 124 cm thick	Total cross section	Compton Spectrometer	10-30 MeV	No			
Grooved Crystal Spectrometer Attachment for X-Ray Absorption Measurements	link	1968	Si	0.4 cm samples	Total linear attenuation	Grovved crystal spectroscopy	8 keV	No			
Systematische Untersuchung der Schwächungskoeffizienten von Elementen der Ordnungszahlen 1 bis 30 bezüglich Gamma-bzw. Röntgenstrahlung im Energiebereich 6 bis 85 keV	link	1965	Si	Unknown	Total mass attenuation	Unknown	52 keV	No			

Röntgenstrahlung im Energiebereich 6 bis 85 keV													
Absolute X-Ray Scattering Factors of Silicon and Germanium	link	1964	Si, Ge	Ground slabs	Total linear attenuation measured, not reported	Scattering/reflection	17 keV	No					
Measurement of the Mean and Anomalous Absorption Coefficients with the Three-Crystal X-Ray Spectrometer	link	1964	Si	~95 mm thick crystals	Total linear attenuation	Three crystal x-ray spectrometer	8 keV	No					
Etude Experimentale des Reflexions Integrees Absolues des Rayons X par Transmission	link	1961	Si	5mm thick crystal	Unknown if measured	Double crystal x-ray spectroscopy	17 keV	No					
X-Ray Absorption Coefficients of the Elements with Z 1 to 17 for Mo K-alpha Radiation	link	1958	Si	Solution	Total mass attenuation, and "true" mass attenuation	Light intensity	17 keV	No					
Absorption and Emission Spectra of Silicon and Germanium in the Soft X-Ray Region	link	1956	Si, Ge	Evaporation of crystals, 1000 A thick	Total linear attenuation	Light intensity	60-200 eV	No					
Über das Absorptionsgesetz für kurzwellige Gamma-Strahlung	link	1931	Si	Unknown	Unknown	Unknown	>1.5 MeV	Unknown					
Die Massenschwächungskoeffizienten der Kohlenstoff-K alpha-Linie in Abhängigkeit von Ordnungszahl	Scan	1968	Si	Compound, SiC	Total mass attenuation (I think)	Unknown	0.277 keV	No					
Absorption of 6.42 MeV Photons	link	1975	Ge	Order of one mean free path	Total mass attenuation	Light intensity	6.42 keV	No					
Fine structure in the absorption-edge spectrum of Ge	link	1957	Ge	>0.0425 cm thick crystal	Total linear attenuation	Light intensity	<1 eV	Yes					
Absorption of X-Rays in Germanium	link	1968	Ge	0.04 mm thick crystal	Pe absorpton coefficient	Light intensity	>5 keV	No					
Optical Absorption of Semiconductors from 15 to 170 eV	link, p209	1970	Ge	Crystal	Total linear attenuation	Light intensity	>15 eV	No					
Pendellösung Measurement of the Atomic Scattering Factor of Germanium	link	1967	Ge	<0.03 mm thick crystals	Form factors	Pendellösung	22 keV	No					
Anomalous Transmission of X-Rays in Perfect Single Germanium Crystals at Liquid Nitrogen Temperature	link	1965	Ge	>0.03 cm thick	Ratio of intensities	Light intensity	22 keV	Yes					
Effect of Dynamical Diffraction in X-Ray Fluorescence Scattering	link	1963	Ge	Crystal	Scattering	Double crystal diffraction	>10 keV	No					
Effect of Thermal Vibrations on Diffraction from Perfect Crystals I. The Case of Anomalous Transmission	link	1962	Ge	25 um crystal	Form factors	Light intensity	8 keV	Yes					
Messungen der anomalen Durchlässigkeit und der Reflexion von Röntgenstrahlen an guten Germanium-Einkristallen im Bragg-Fall der Interferenz Vergleich mit der dynamischen Theorie der Röntgeninterferenzen	link	1961	Ge	Unknown	Unknown	Unknown, light intensity?	8 keV	Unknown					
M2,3 Absorption Spectra of the Elemental Solids Cr through Ge	link	1957	Ge	Deposited layers	Total mass attenuation	Light intensity	>36 eV	No					
The Absolute Absorption Coefficient of Germanium and the Fine Structure in the K Edge of some of Its Compounds	link	1951	Ge	Compounds	Attenuation	Light intensity	>11 keV	No					
Reflection of X Rays from Certain Substances in the Region 7 to 44 A	Scan	1965	Ge	Unknown	Linear attenuation of reflection	Light intensity	>114 eV	No					
Investigation of the Energy Structure of Si and SiO2 by Ultrasoft X-Ray Emission and Absorption Spectroscopy	Scan	1965	Si	>1800 A thick samples	Total linear attenuation	Light intensity	>90 eV	No					
The Coefficient of Absorption of Co60 gamma-rays by Semiconductors	Scan	1958	Si, Ge	Unknown	Total linear attenuation	Light intensity	>1 MeV	Yes					

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Dark Photon

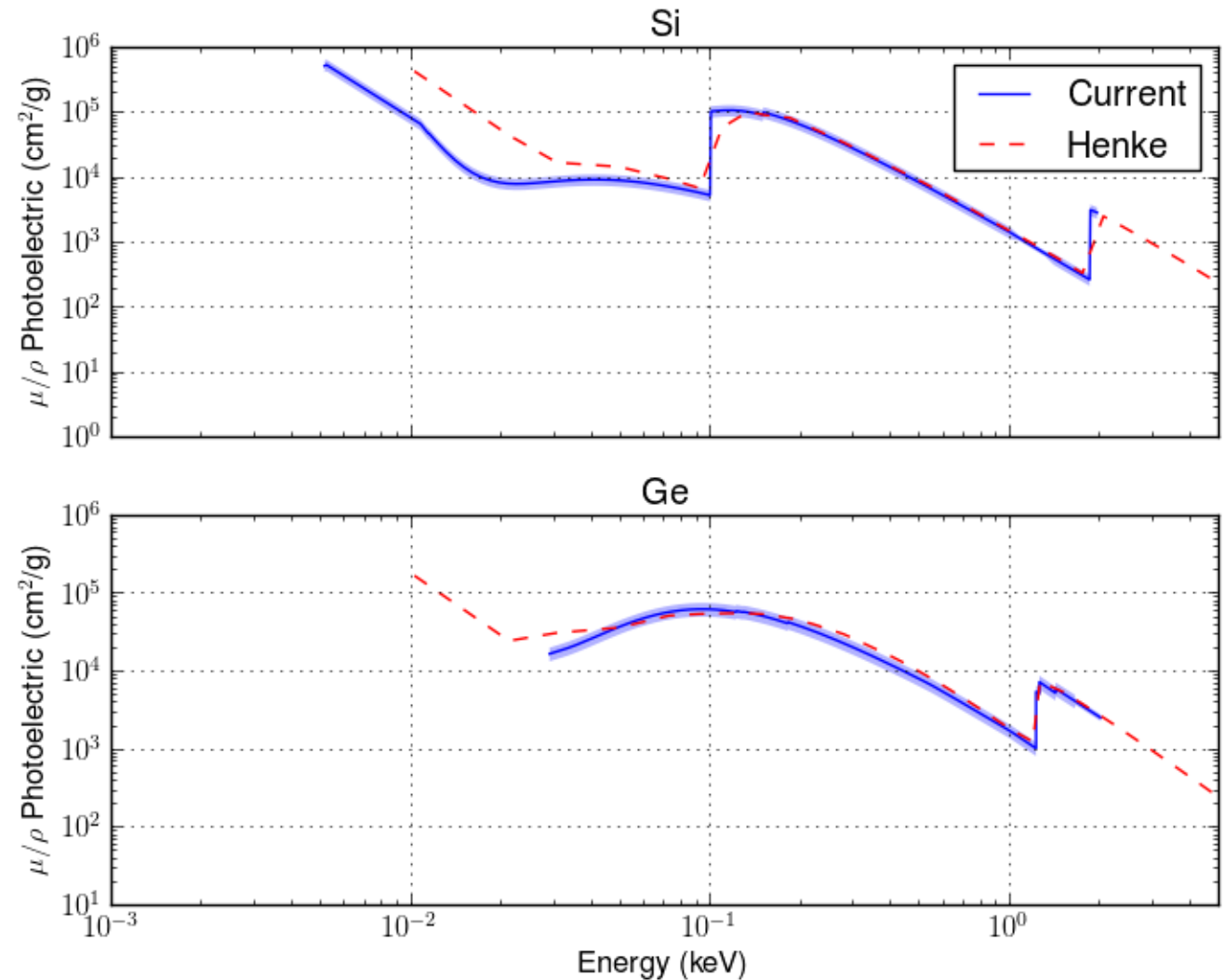
- What does the landscape look like?
- Below 1 keV energy – minimal, but some exists. Even less for below 100 eV.
- Lower temperatures – minimal, tends to look at liquid nitrogen temperatures (~ 77 K)
- Our temperatures (mK range) – no data found.

Dark Photon

I want to add the experimental data to these plots, for comparison. Also, this should be extended to 20 keV.

Challenges:

- Not all experimental data is provided in data tables – some just show plots
- Some of the data comes in different forms. Much of the data is **Total** mass attenuation, or **total** linear attenuation. What is the best way to isolate photoelectric term?
- Uncertainties in data is not always clear.



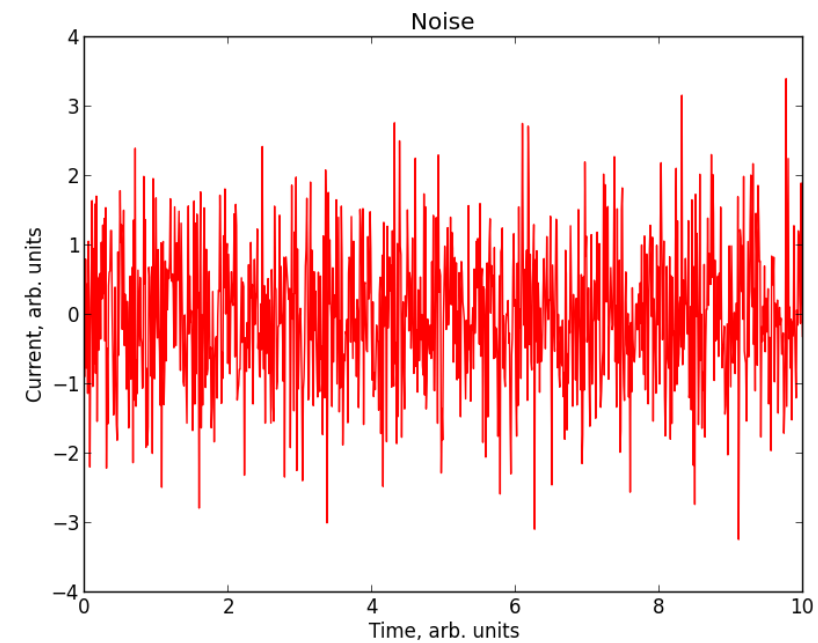
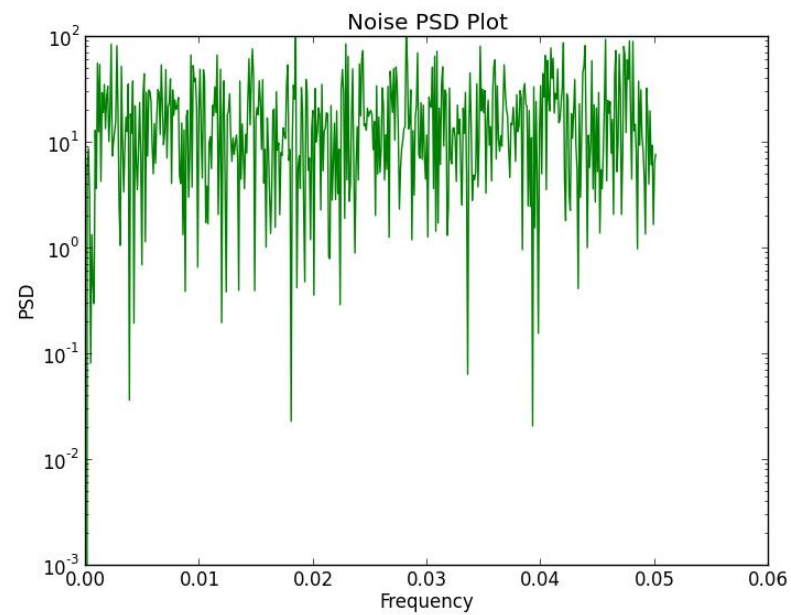
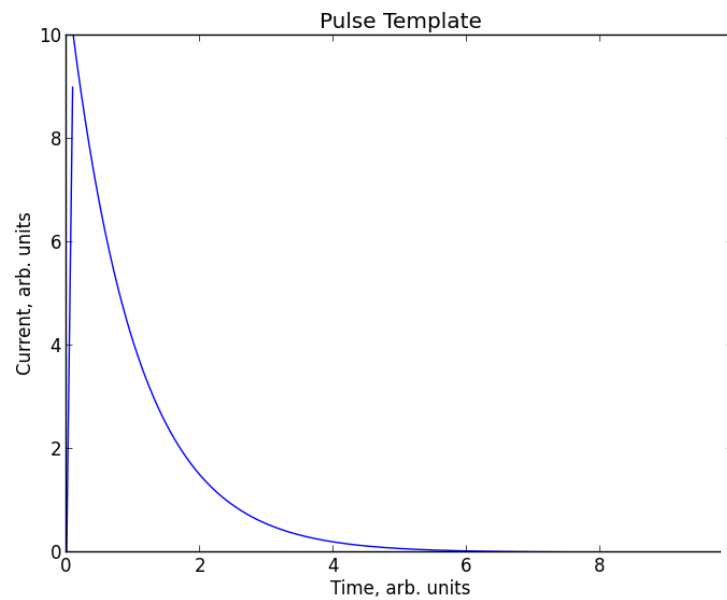
Dark Photon

- On Belina's suggestion, talk with condensed matter people here to understand better this "atomic-like" assumptions and its implications.
- It is clear that temperature has a significant impact of photoelectric absorption cross section, and there is little (or no) experimental data.
- Most of the experiments use some version of the light intensity method to obtain their data.
- There are methods I have founds that have been able to measure sub 100 eV photon range.

DQM

- I have a very rough version of code that makes a decision based on energy resolution.
- This includes generating pulse template, generating noise signal, and calculating noise PSD. This presumably will already be done by CDMSBats.

DQM



DQM

- Last part of code:
 - Calculate energy resolution – already RQ, so this would be done by CDMSBats
 - Make a decision based on threshold values.
 - 3 thresholds, makes a decision based on where energy resolution falls within thresholds
- I don't think I'm calculating the PSD and/or the energy resolution correctly, but that does not affect the decision part of the code.

DQM

- Want to find Scott Fallows' code, which grabs the PSD from input root file.
 - For SNOLAB, it will be an input MIDAS file
- Where does this code exist? Is it part of CDMSBats? Or separate?
Determines how to access data.
- Work on decision based on frequency dependent threshold on noise PSD, both min and max thresholds.