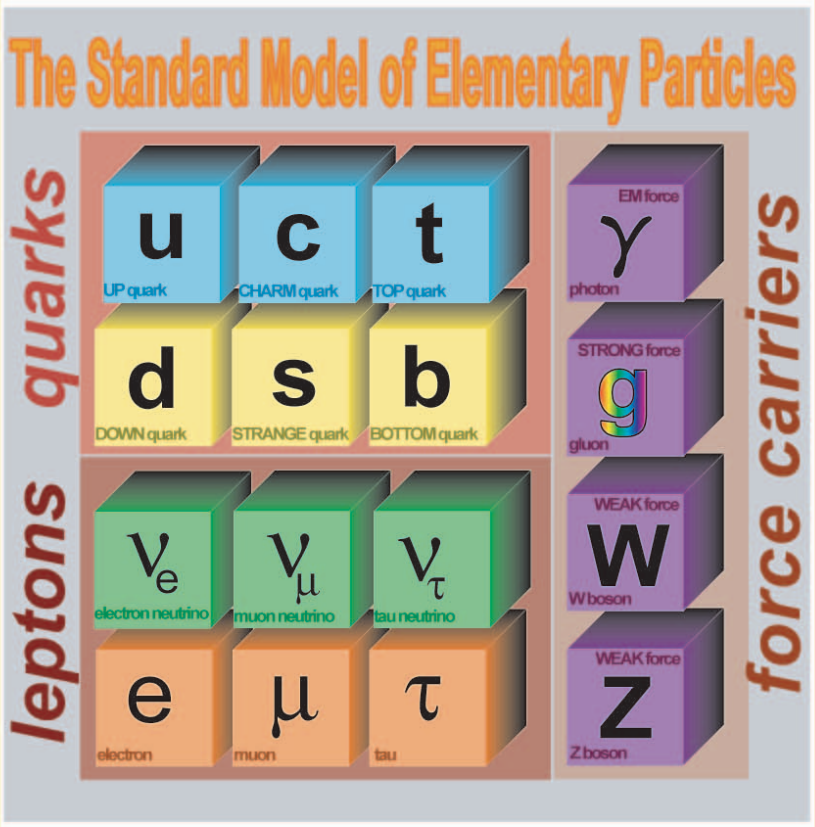
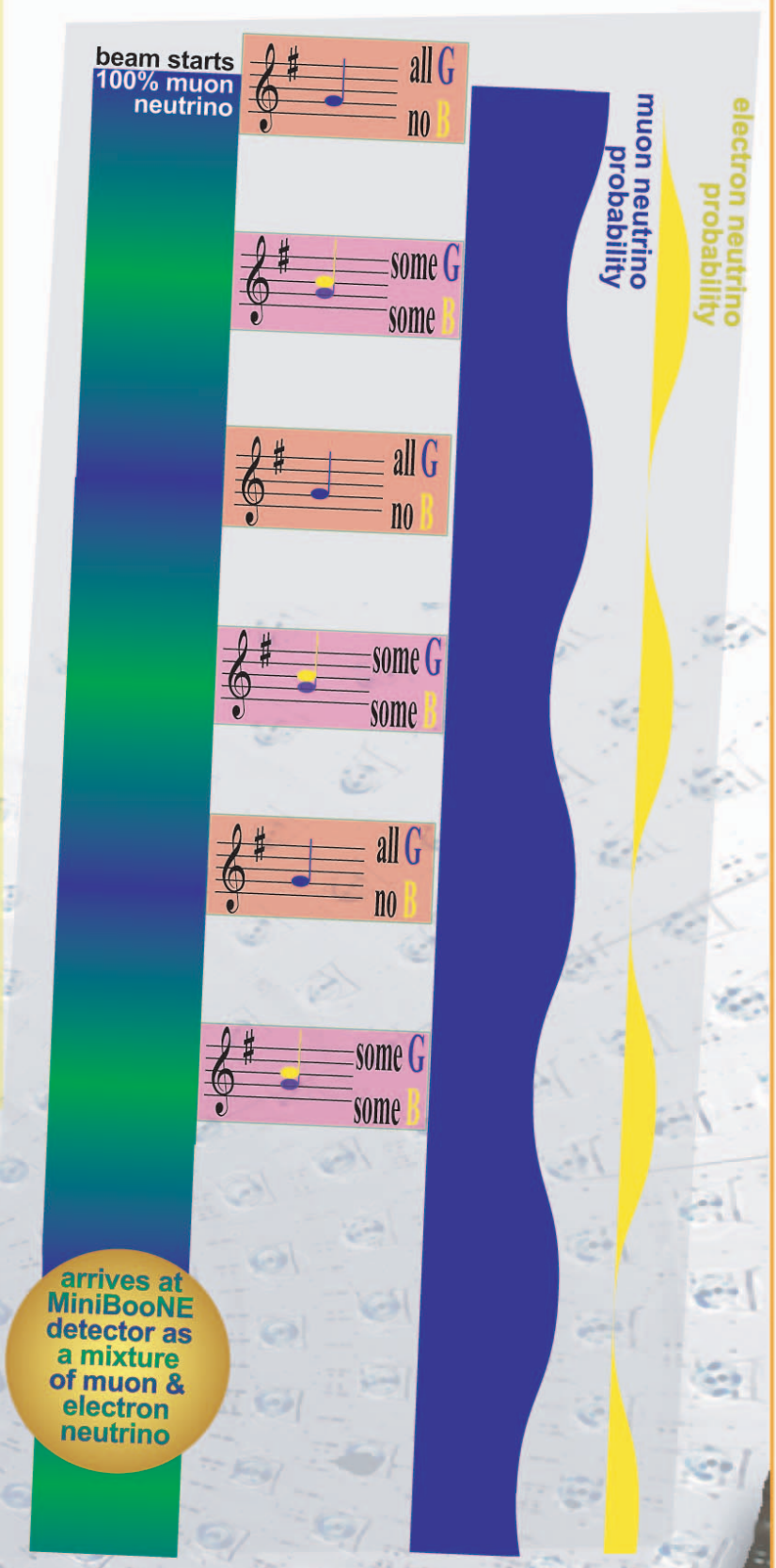
Of neutrino mass, and oscillation



The theory known as the Standard Model says that all three kinds (or flavors) of neutrino – electron, muon and tau – are massless. In addition, Standard Model neutrinos scrupulously adhere to lepton family rules. When neutrinos interact or are produced in a decay, both the number and the flavor of the leptons must not change, before and after. Nuclear decays producing an electron always make an electron ANTI-neutrino: pions decay to muon neutrinos and ANTI-muons.

Oscillations, though, show that neutrinos are NOT massless, and they CAN change flavor. MiniBooNE's beam starts out as almost 100% pure muon neutrinos. If, when it arrives at the tank, signals from electron or tau neutrinos show up, we'll have seen oscillations! Neutrinos oscillating means neutrinos with mass, and that opens many new doors on our understanding of how particles – and galaxies – and universes - work.



Suppose you could only hear one pitch (or frequency) of sound at a time – your "sound detector" could only tell, "That note was a G," or "That was a B." The Standard Model says, "If a note starts out as a G [or a B], it stays that way forever; hearing a note as a G means it was made by a process that only generates G's." Oscillations play by different rules, and admit the possibility that a note originating as a G (a muon neutrino, say) can "de-tune" as it travels, developing a B component (electron neutrino). Does this mean that you would hear chords in neutrino beams? No – remember, you can only hear one pitch at a time. What it *does* mean is that if you had a beam created purely of 1000 G's, and set up a listening post some distance away, you might get 990 G's – and 10 B's. What oscillates in neutrino oscillations is the *probability* – the likelihood that a neutrino created of one kind stays of that kind permanently, or if it has some chance of changing its kind.

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