Atmospheric and Solar Neutrino Observations

Consider the three generations of neutrinos:
nu_e (electron neutrino); **nu_m** (muon neutrino); **nu_t**
and three neutrino mass states: **nu_1 ; nu_2 : nu_3**
and
the division of 8-dimensional spacetime into
4-dimensional physical Minkowski spacetime
plus
4-dimensional CP2 internal symmetry space.

The lightest mass state nu_1 corresponds to a neutrino
whose propagation begins and ends in physical Minkowski spacetime,
lying entirely therein. According to the D4-D5-E6-E7-E8 VoDou Physics Model the mass of nu_1 is zero at tree-level
and it picks up no first-order correction while propagating
entirely through physical Minkowski spacetime,
so
the first-order corrected mass of nu_1 is zero.

Since only two of the three neutrinos have first-order mass,
and since in the D4-D5-E6-E7-E8 VoDou Physics Model the
neutrinos are not Majorana particles,
there is no neutrino CP-violation or phase at first order.

Consider the neutrino mixing matrix

	nu_1	nu_2	nu_3
nu_e	Ue1	Ue2	Ue3
nu_m	Um1	Um2	Um3
nu_t	Ut1	Ut2	Ut3

Assume the simplest mixing scheme with a massless nu_1
and
nu_3 has no nu_e component so that Ue3 = 0 or, in conventional
notation, mixing angle theta_13 = 0 = sin(theta_13)
and cos(theta_13) = 1.
Then we have (as described in the 2004 [Particle Data Book]()):

	nu_1	nu_2	nu_3
nu_e	cos(theta_12)	sin(theta_12)	0
nu_m	-sin(theta_12)cos(theta_23)	cos(theta_12)cos(theta_23)	sin(theta_23)
nu_t	sin(theta_12)sin(theta_23)	-cos(theta_12)sin(theta_23)	cos(theta_23)

Assume that nu_3 has equal components of nu_m and nu_t so
that Um3 = Ut3 = 1/sqrt(2) or, in conventional
notation, mixing angle theta_23 = pi/4.
Then we have:

	nu_1	nu_2	nu_3
nu_e	cos(theta_12)	sin(theta_12)	0
nu_m	-sin(theta_12)/sqrt(2)	cos(theta_12)/sqrt(2)	1/sqrt(2)
nu_t	sin(theta_12)/sqrt(2)	-cos(theta_12)/sqrt(2)	1/sqrt(2)

The heaviest mass state nu_3 corresponds to a neutrino
whose propagation begins and ends in CP2 internal symmetry space,
lying entirely therein. According to the [D4-D5-E6-E7-E8 VoDou Physics Model]() the mass of nu_3 is zero at tree-level
but it picks up a first-order correction propagating
entirely through internal symmetry space by
merging with an electron through the weak and electromagnetic forces,
effectively acting not merely as a point
but
as a point plus an electron loop at both beginning and ending points
so
the first-order corrected mass of nu_3 is given by
M_nu_3 x (1/sqrt(2)) = M_e x GW(mproton^2) x alpha_E
where the factor (1/sqrt(2)) comes from the Ut3 component
of the neutrino mixing matrix

so that
M_nu_3 = sqrt(2) x M_e x GW(mproton^2) x alpha_E =
= 1.4 x 5 x 10^5 x 1.05 x 10^(-5) x (1/137) eV =
= 7.35 / 137 = **5.4 x 10^(-2) eV**.
Note that the neutrino-plus-electron loop can be anchored
by weak force action through any of the 6 first-generation quarks
at each of the beginning and ending points, and that the
anchor quark at the beginning point can be different from
the anchor quark at the ending point,
so that there are 6x6 = 36 different possible anchorings.

The intermediate mass state nu_2 corresponds to a neutrino
whose propagation begins or ends in CP2 internal symmetry space
and ends or begins in physical Minkowski spacetime,
thus having only one point (either beginning or ending) lying
in CP2 internal symmetry space where it can act not merely
as a point but as a point plus an electron loop.
According to the D4-D5-E6-E7-E8 VoDou Physics Model the mass
of nu_2 is zero at tree-level
but it picks up a first-order correction at only one (but not both)
of the beginning or ending points
so that so that there are 6 different possible anchorings
for nu_2 first-order corrections, as opposed to the 36 different
possible anchorings for nu_3 first-order corrections,
so that
the first-order corrected mass of nu_2 is less than
the first-order corrected mass of nu_3 by a factor of 6,
so
the first-order corrected mass of nu_2 is
M_nu_2 = M_nu_3 / Vol(CP2) = 5.4 x 10^(-2) / 6
= 9 x 10^(-3)eV.

Therefore:

the mass-squared difference D(M23^2) = M_nu_3^2 - M_nu_2^2 =
= (2916 - 81) x 10^(-6) eV^2 =
= 2.8 x 10^(-3) eV^2

and

the mass-squared difference D(M12^2) = M_nu_2^2 - M_nu_1^2 =
= (81 - 0) x 10^(-6) eV^2 =
= 8.1 x 10^(-5) eV^2

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Set theta_12 = pi/6 so that cos(theta_12) = 0.866 = sqrt(3)/2
and sin(theta_12) = 0.5 = 1/2 = Ue2 = fraction of nu_2 begin/end
points that are in the physical spacetime where massless nu_e lives.
Then we have for the neutrino mixing matrix:
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	nu_1	nu_2	nu_3
nu_e	0.87	0.50	0
nu_m	-0.35	0.61	0.71
nu_t	0.35	-0.61	0.71

The above model is substantially consistent with experimental results as described in the 2004 Particle Data Book and in the presentation by deGouvea at the 2004 APS DPF meeting at UC Riverside, and it provides an intuitive physical understanding of those results.