New relations between Oscillation Symmetry periods

Boris Tatischeff
Université Paris-Saclay, CNRS/IN2P3, IJCLab, Orsay Cedex, France

The Oscillation Symmetry is applied with success to several meson and baryon data containing some new mass (and or width) data since our previous similar study. The extracted periods display again a "like quantification behaviour".

The W boson and fermion "mass data" are fairly well aligned indicating a new property between these particles. Thus contrary to the generally accepted belief that the paericle masses have no relationship with each other, this work seems to suggest that they do through the Oscillation Symmetry.

I. INTRODUCTION

It was shown recently that successive values belonging to the same entity obey a simple relationship. In the same way as opposite kinetic and potential forces produce oscillations in classical physics, the successive values produce also oscillations in quantum physics [1]. This property is called: Oscillation Symmetry.

This symmetry is observed in successive particle (meson or baryon) masses and widths, and also in decay mode fractions. Likewise this property was observed when electromagnetic interactions of some particles, nuclei, and atoms were studied. The same observation was obtained in the study of mass or radius in astrophysical bodys. Also obtained in the physical properties of the Periodic Table of some Atomic Elements. These results are published in several papers whose references are recalled in [2].

When successive values of a single property (often masses) are considered, the data are classified in increasing order and then studied using the following relation:

$$m_{(n+1)} - m_n = f[(m_{(n+1)} + m_n)/2] \tag{1}$$

where n indicates the increasing data order. Therefore the differences between two successive data are plotted versus their corresponding mean values. Such presentation of data is named "mass data".

When two different properties belonging to the same data are considered, the second property data are plotted versus the first one. This is illustrated in fig.1, previously reported in [3], showing respectively the "mass data" and the width data for ω mesons in inserts (a) and (c). Inserts (b) and (d), show respectively the "mass data" and the width data for ρ mesons.

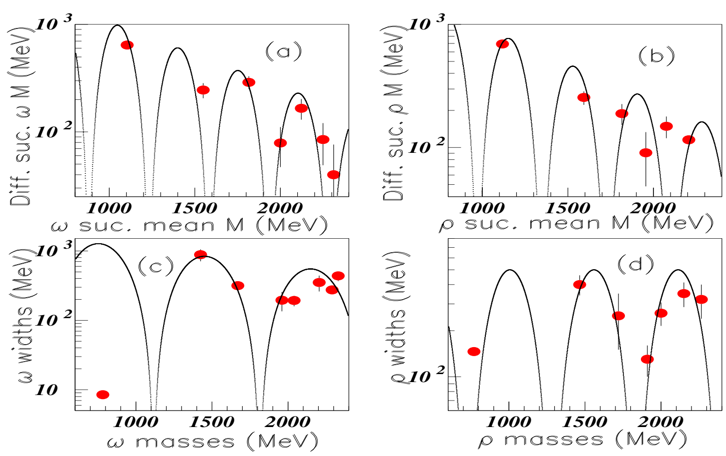

FIG. 1. Color on line. Inserts (a) and (c), show respectively the "mass data" and the width data for ω mesons. Inserts (b) and (d), show respectively the "mass data" and the width data for ρ mesons. (See text)

The oscillations are fitted using a normalized cosine function:

$$y = \alpha(1 + cos(x/x_1))exp(\beta.x)$$

where x/x_1 is defined within 2π. The oscillation period P= $2\pi * x_1$, α, and β, are the three fitted parameters whose values, extracted from the present work are reported in the following tables. The α and β values are not important since they depend on the limits of the fitted area. The period is important and will be discussed.

It is observed that the same oscillation periods are extracted from different data (eventually subject to a data translation or after the application of an homothetic factor). Fig. 2, published already

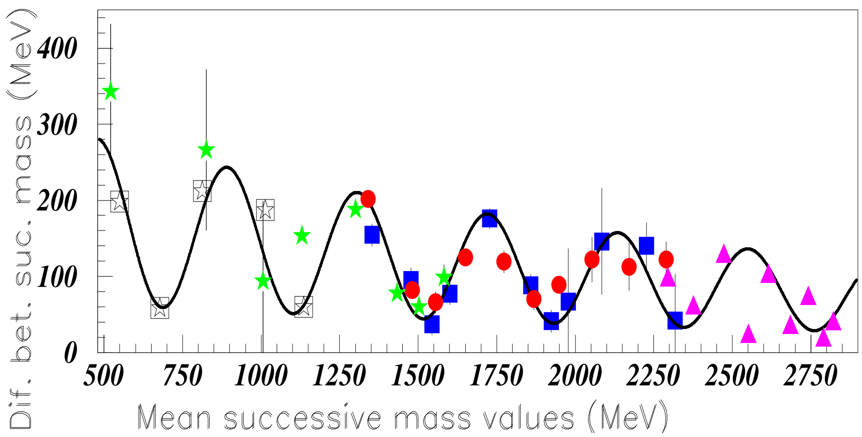

FIG. 2. Mass data of several particles and hadrons.

TABLE I. Quantitative values of some mesons fit parameters. The oscillation periods P are almost the same and differ from their average value by ΔP.

Fig.	Mesons	α (MeV)	β (MeV)	P (MeV)
3(a)	c$\bar{c}$ $0^-,(1^{--})$ m.	5750	-0.00085	493.2
3(b)	c$\bar{c}$ $0^-,(1^{--})$ Γ_T	0.22	0.0014	527.8
3(c)	b$\bar{b}$ $0^-,(1^{--})$ m.	$5*10^7$	-0.0012	483.8
3(d)	b$\bar{b}$ $0^-,(1^{--})$ Γ_T	$7*10^{-6}$	0.0014	521.5
4(a)	Bottom mass	200	0	120.2
4(b)	Bottom Γ_T	120	0	121.9
4(c)	Bottom strange mass	0.079	0.0013	116.9
4(d)	Bottom strange Γ_T	$3.35*10^{-6}$	0.0027	113.1

in [4] illustrates this observation which corresponds to mass data of f_2 and f_0 mesons, Ξ and Ξ_C baryons, and ^{14}N excited state levels. Different marks and fit parameters correspond to different data and are given in fig.19 of [4].

The present paper uses the current meson and baryon data [5]. All periods are as large as possible, since it is clear that smaller values agree also.

II. MESONS

The meson c$\bar{c}$ $0^-(1^{--})$ and $b\bar{b}$ $0^-(1^{--})$ "mass data", width data and fits are shown in fig.3. The same period (to within 1%) of the "mass data" oscillations (P=488.5 MeV) is obtained for c$\bar{c}$ (P=493.2 MeV) and b$\bar{b}$ (P=483.8 MeV) oscillations. Likewise the same period P=524.6 MeV (within 0.6%) describes the two width oscillations (P=527.8 MeV and P=521.5 MeV). The Oscillation Symmetry of the other mesons was systematically studied in [3]. The corresponding figs. are summarized in the following table and the fitted parameters shown in table A2 of [3]. We observe close oscillation periods (small ΔP values) except for the D^+ and D_S^+ mesons and for the following mesons:

- The oscillation periods [3] of the strange meson data are highly dispersed. Their masses are sometimes reported to be complex, their widths are large, sometimes very large. The strange meson data are therefore not reanalyzed here.

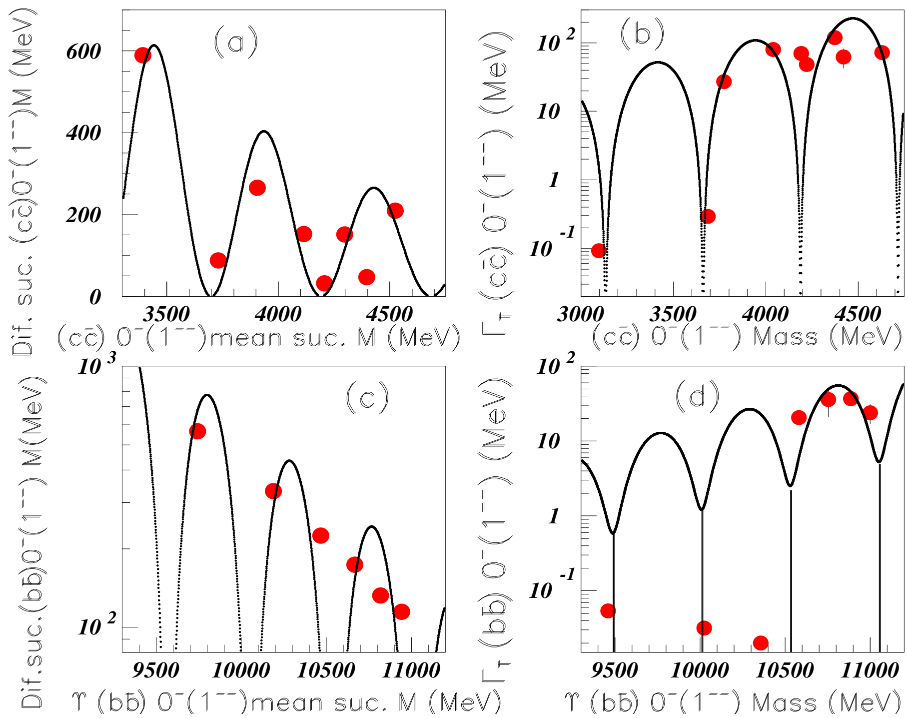

FIG. 3. $c\bar{c}$ $0^-,(1^{--})$ and $b\bar{b}$ $0^-,(1^{--})$ "mass data" in inserts (a) and (c) and widths in inserts (b) and (d).

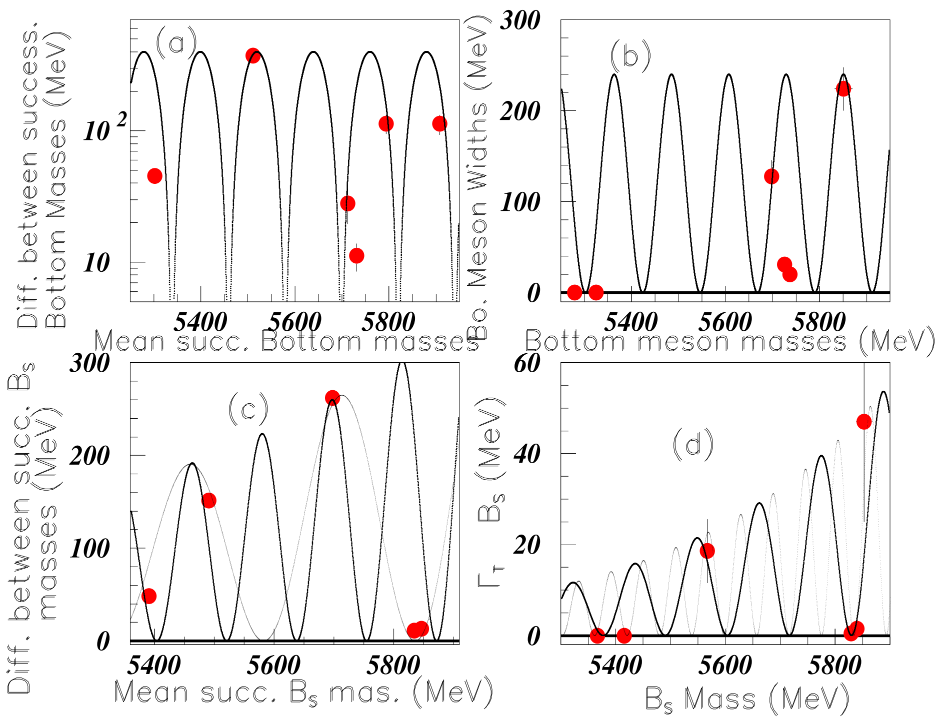

FIG. 4. Bottom and Bottom Strange meson "mass data" in inserts (a) and (c) and widths in inserts (b) and (d).

TABLE II. Quantitative values of the mesons fit parameters extracted in [3]. The oscillation periods P are almost the same and differ from their average value by ΔP.

Fig. in [3]	Mesons	P (MeV)	ΔP
1(a) and 1(b)	f_0 and f_2 "mass"	375.2	0.47 %
1(c) and 1(d)	f_0 and f_2 width	365.0	1.9 %
2(a) and 2(b)	η and ρ "mass"	293.7	0.53 %
2(c) and 2(d)	η and ρ width	348.7	0.90 %
4(a) and 4(c)	D^+ and D_S^+ "mass"	180.35	8.0 %
4(c) and 4(d)	D^+ and D_S^+ width	182.3	13.8 %

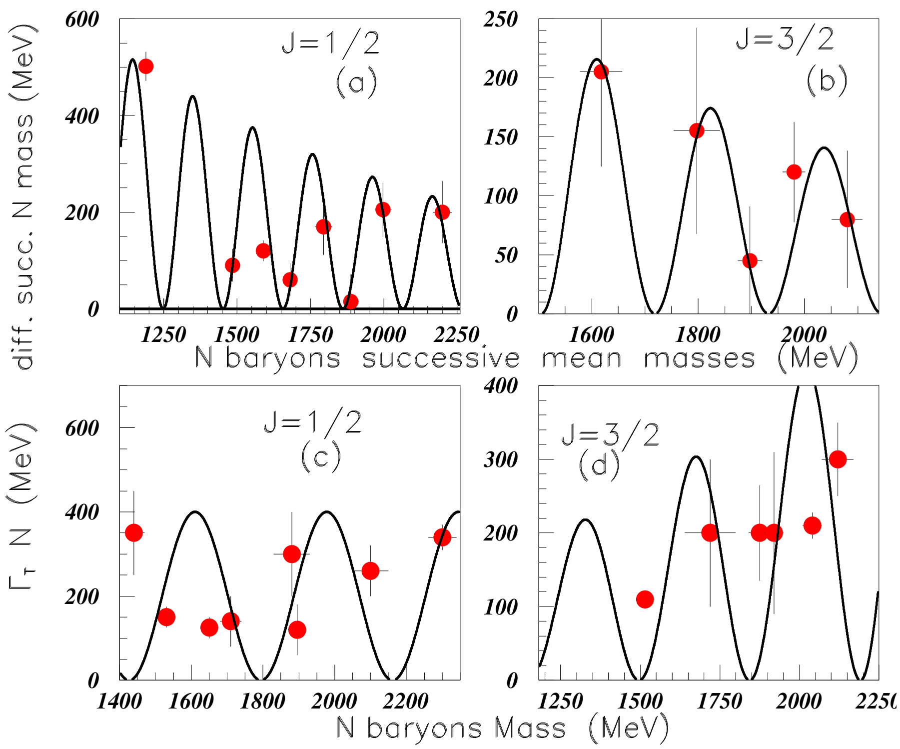

FIG. 5. N J=1/2 and J=3/2 baryons "mass data" in inserts (a) and (c) and corresponding widths in inserts (b) and (d).

- The bottom meson fits shown previously in fig.5 and Table A1 in [3] display scattered values. Fig.4 shown below reproduces the fit of [3] with dashed lines. New fits are shown with full lines. They are not modified for inserts (a) P=120.2 MeV and (b) P=121.9 MeV, but the period of insert (c) is forced to be approximately twice as small as that obtained in [3]: P=116.9 MeV (previously 253.2 MeV), and the period of insert (d) is modified to be approximately twice that obtained in [3]: P=113.1 MeV (previously 59.1 MeV). Using these new periods, the mean period of B and B_S "masses" is then P=118.5 (1.4 %) and the mean period of B and B_S width is then P=117.5 (3.7 %). So the greater the number of data, the better the fit definition.

III. BARYONS

The N baryon "mass data" and widths are shown in fig.5. Insert (a) shows the N J=1/2 "mass data" (P=204.2 MeV). Insert (c) shows the corresponding total widths (P=213.6 MeV). Insert (c)

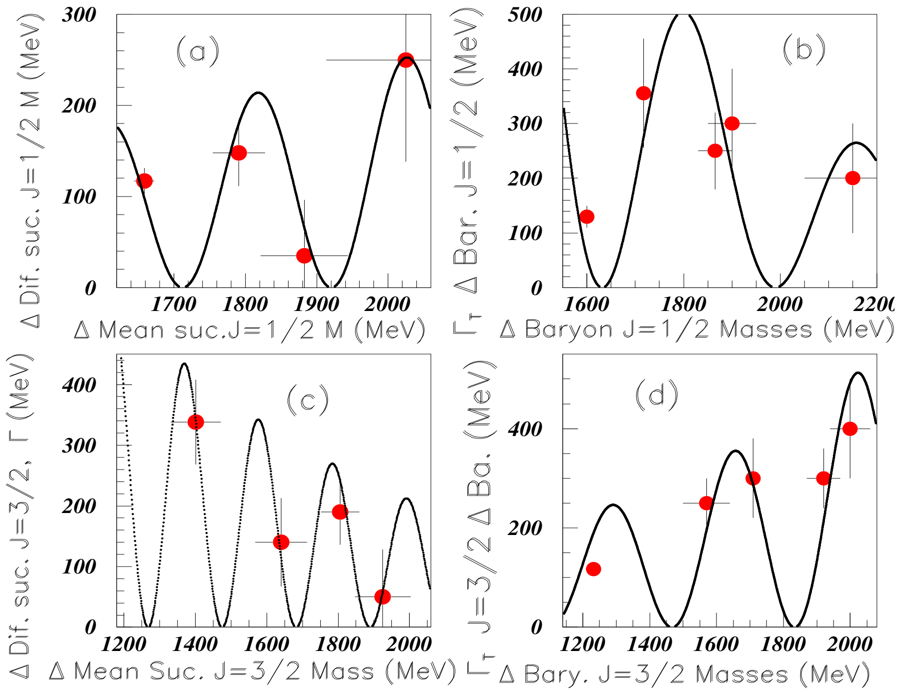

FIG. 6. Δ J=1/2 and J=3/2 baryons ”mass data” in inserts (a) and (c) and corresponding widths in inserts (b) and (d).

TABLE III. Quantitative values of the baryon fit parameters. The oscillation periods P are almost the same and differ from their average value by ΔP.

Fig.	Physics	α(MeV)	β(MeV)	P(MeV)
5(a)	N J=1/2 ”mass data”	630	-0.00078	204.2
5(b)	N J=3/2 ”mass data”	540	-0.001	213.6
5(c)	N J=1/2 Γ_T	200	0	367.6
5(d)	N J=3/2 Γ_T	31	0.00095	348.1
6(a)	Δ J=1/2 ”mass data”	25	0.0008	208.3
6(b)	Δ J=1/2 Γ_T	6500	-0.0018	358.1
6(c)	Δ J=3/2 ”mass data”	1050	-0.00115	207.3
6(d)	Δ J=3/2 Γ_T	34	0.001	366.3

shows the N J=3/2 ”mass data” (P=367.6 MeV). Insert (d) shows the corresponding total widths (P=348.0 MeV).

The Δ ”mass data” and Γ_T values are shown in fig.6. The small number of data results in poor definition of the fits. Insert (a) shows the Δ J=1/2 ”mass data” (P=208.3 MeV). Insert (b) shows the corresponding total widths (P=358.1 MeV). Insert (c) shows the Δ J=3/2 ”mass data” (P=207.3 MeV). Insert (d) shows the corresponding total widths (P=366.3 MeV). The limited number of data of N and Δ is responsible of poor period precision.

We observe close oscillation periods for studied unflavoured baryon ”mass data”, independently of their spin and their isospin. The values extracted above lead to the following average: P(mass)=207.5 MeV (0.24%). We observe also close oscillation periods for unflavoured baryon widths, independently of their spin and their isospin, leading to the average: P(width)=362.2 MeV (1.2%).

The Oscillation Symmetry ”mass data” of the heavier baryons containing one (or more) ”s” quark(s): Λ, Σ, Ξ or Ω are studied in fig. 7. An unique fit describes the ”mass data” of these

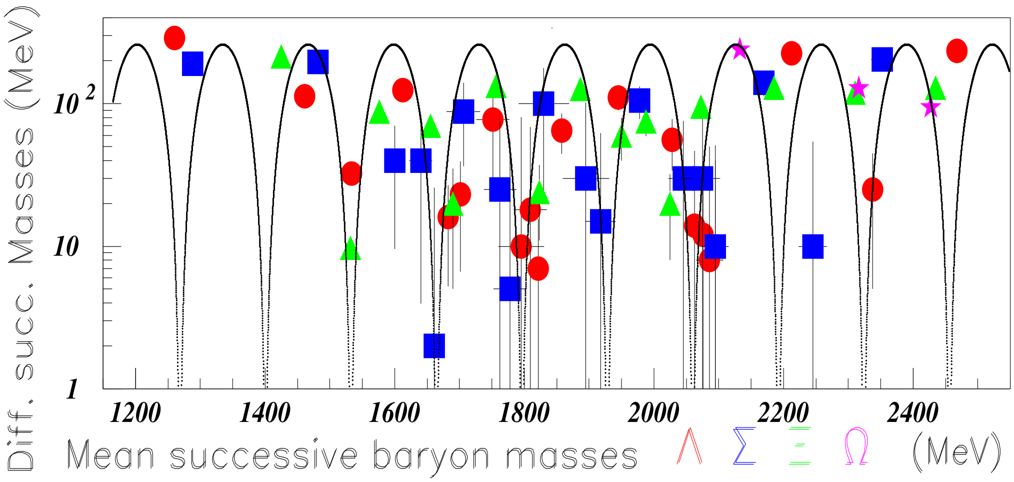

FIG. 7. "Mass data" and fit for Λ (full red circles), Σ (full blue squares), Ξ (full green triangles), and Ω (full magenta stars).

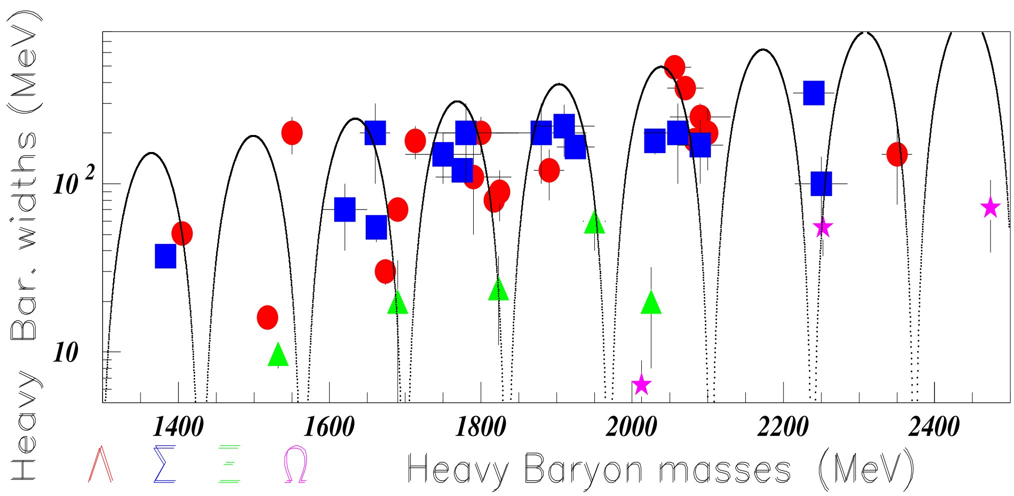

FIG. 8. Total width and fit for unflavoured heavy baryons: Λ (full red circles), Σ (full blue squares), Ξ (full green triangles), and Ω (full magenta stars).

many baryons. The corresponding total widths are studied in fig. 8 fitted also with an unique fit. The two oscillation periods ("mass data" and width) of these baryons are nearly the same with average value: P=133.3 MeV (1.01%).

Figs. 9 and 10 show the similar data and fit for charmed baryons. Here again, the two oscillation periods ("mass data" and width) of these charmed baryons are nearly the same with average value: P=68.4 MeV (1.8%).

Figs. 11 and 12 show similar data and fit for bottom baryons. We observe here a slightly higher dispersion between the "mass data" and the width oscillation periods of the bottom baryons. The mean value between bottom baryon "mass data" periods and widths oscillation periods is 203.0 MeV (3.1%).

The studies shown before concern "mass data" and widths plotted versus masses. The attempt to study "width data" using equation (1) applied to widths instead to masses, cannot give rise to a valid result due to large imprecisions of the widths compared to their values.

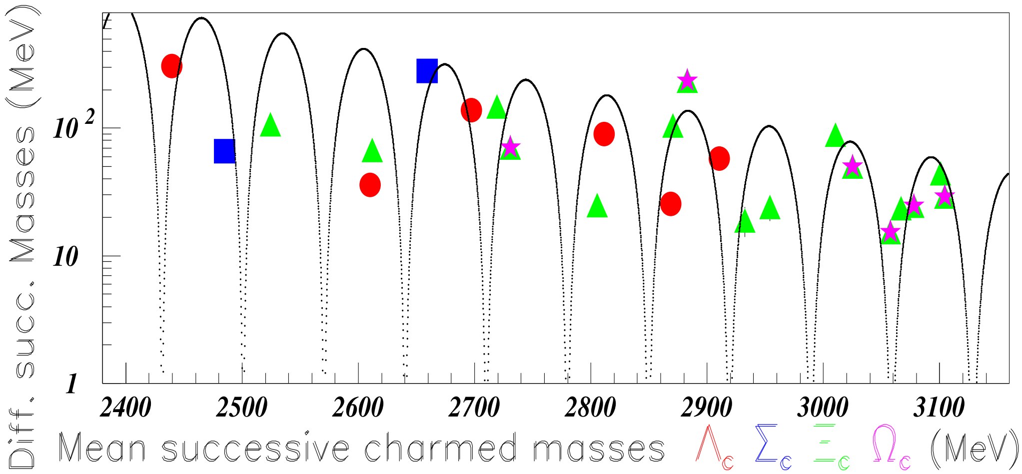

FIG. 9. "Mass data" and fit for charmed baryons: Λ_C (full red circles), Σ_C (full blue squares), Ξ_C (full green triangles), and Ω_C (full magenta stars).

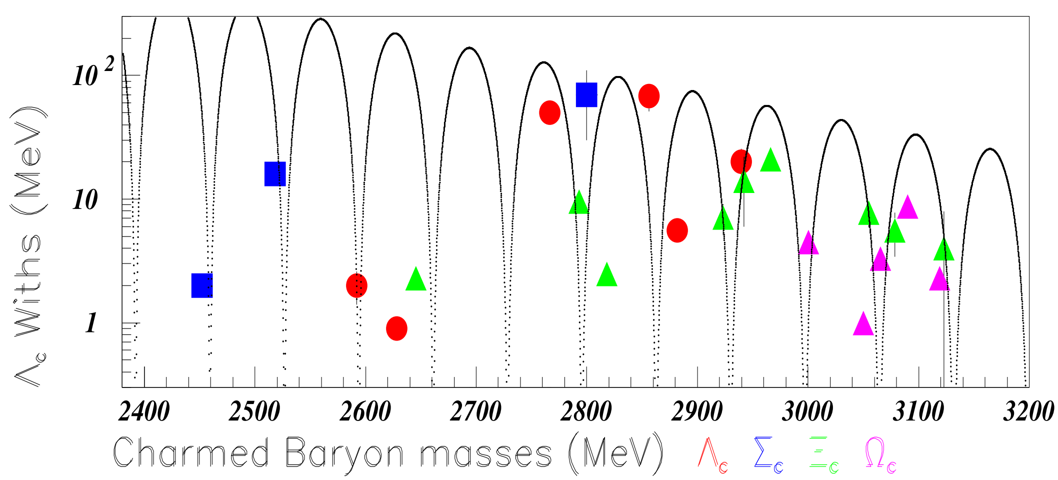

FIG. 10. Total width and fit for charmed baryons: Λ_C (full red circles), Σ_C (full blue squares), Ξ_C (full green triangles), and Ω_C (full magenta stars).

TABLE IV. Quantitative values of the heavy baryon (Λ, Σ, Ξ, and Ω) "mass data" and total widths fit parameters.

Fig.	Heavy baryons	α(MeV)	β(MeV^{-1})	P (MeV)
7	Unflavoured, masses	130	0	131.9
8	Unflavoured, Γ_T	7	0.00175	134.8
9	Charmed, mass	7*10^6	-0.004	69.7
10	Charmed, Γ_T	4*10^6	-0.004	67.2
11	Bottom, mass	150	0	209.2
12	Bottom, Γ_T	3*10^5	0.0021	196.7

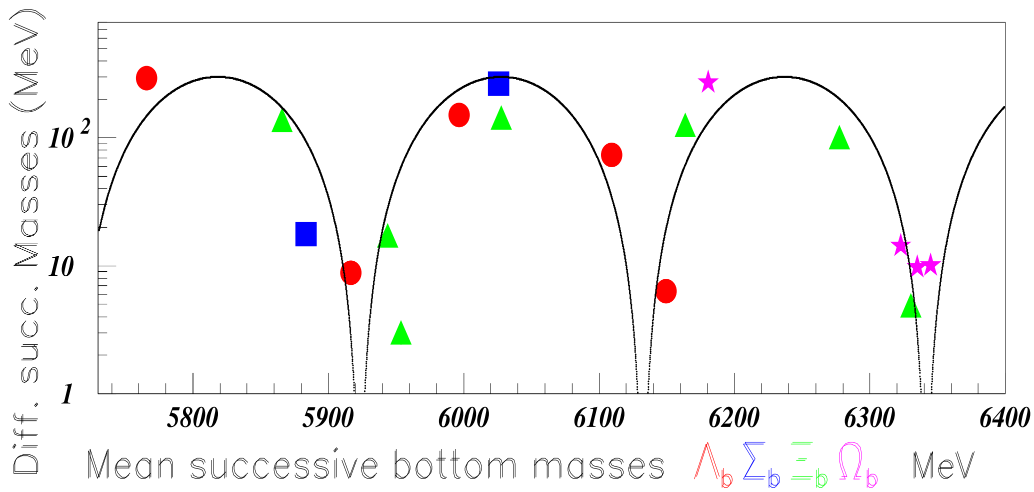

FIG. 11. "mass data" and fit for bottom baryons: Λ_B (full red circles), Σ_B (full blue squares), Ξ_B (full green triangles), and Ω_B (full magenta stars).

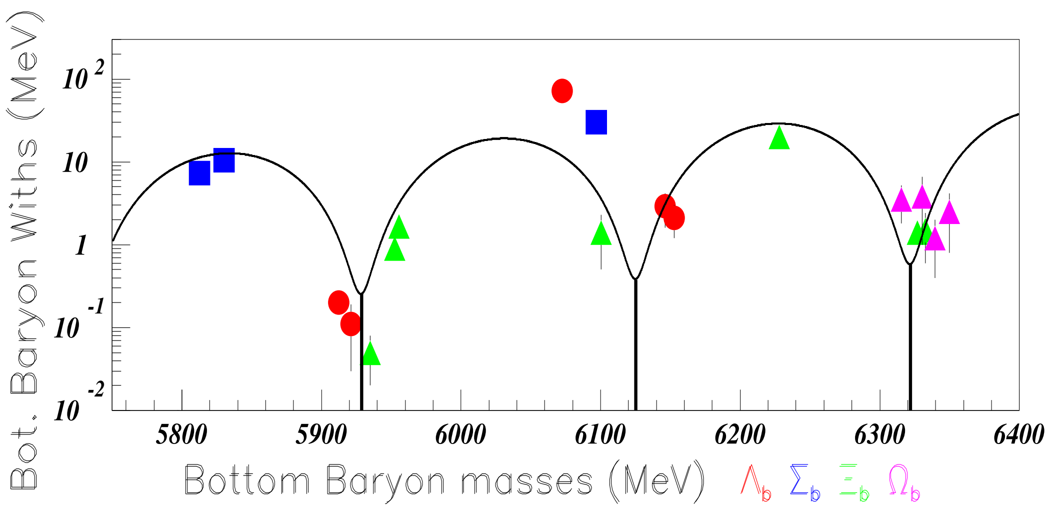

FIG. 12. Total width and fit for bottom baryons: Λ_B (full red circles), Σ_B (full blue squares), Ξ_B (full green triangles), and Ω_B (full magenta stars).

IV. DISCUSSION AND SUMMARY

As shown previously in different papers, the periods of the data analyzed here verify the Oscillation Symmetry. The discussed before "mass data" (full red circles) and widths (full blue squares) periods, are shown in fig.13. They follow a "like quantization" effect, being rather well separated by 20 MeV. This property links apparently independent properties together, suggesting to look for a possible extention to a larger common property.

This assumption is observed in fig.14 where, for several different particles, the difference of successive masses are plotted vesus the corresponding mean values. The data are the quark masses (full red circles), the lepton masses (full blue squares), and the boson masses (full green stars). These all "mass data" are fairly well aligned. The second quark "mass data" is nearly hidden by the second lepton "mass data" since its coordinates (x,y)=(49.0, 88.7) MeV are close to the lepton coordinates

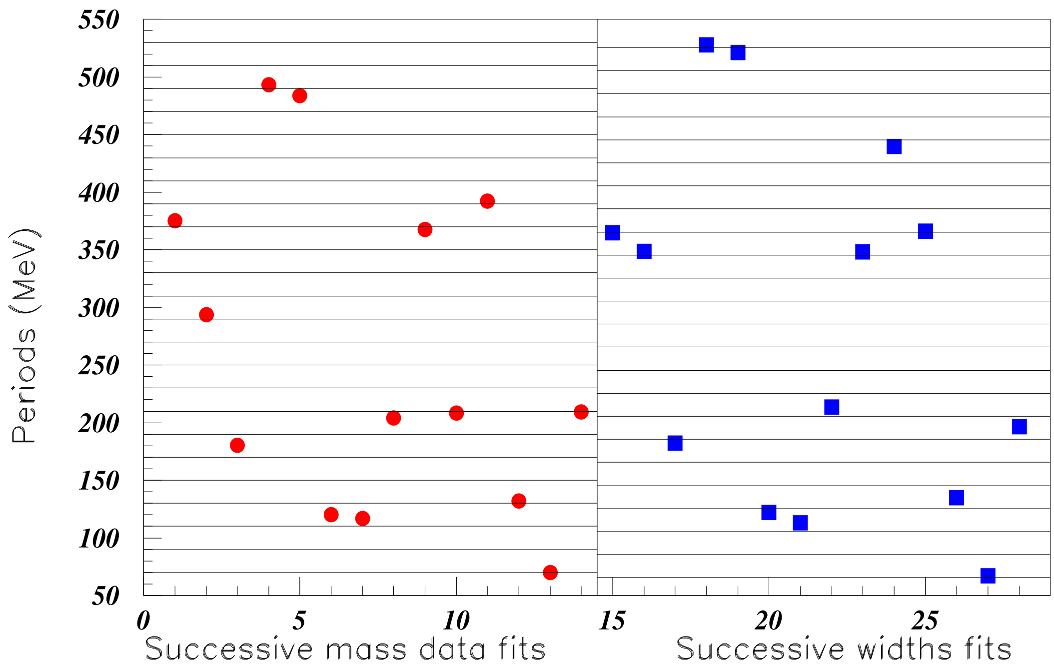

FIG. 13. Meson and baryon period values reported in previous sections. "Mass data" periods in red circles, widths periods in blue squares.

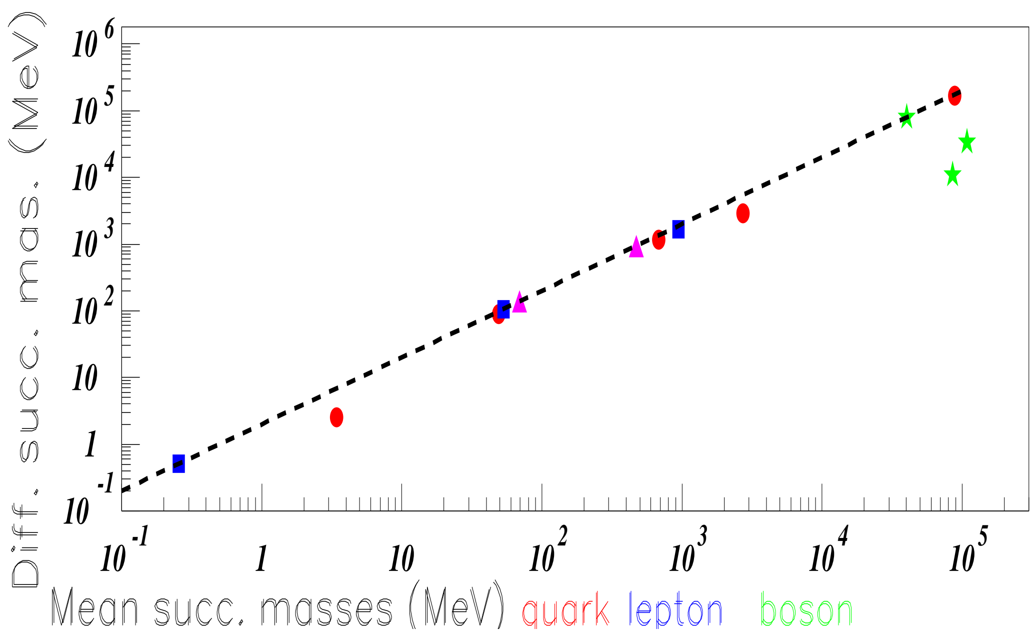

FIG. 14. Lepton, quark, and boson "mass data" (see text).

(53.1, 105.1) MeV. The main exception for alighement is for the two last boson "mass data" (Z and Higgs).

Similarly two (out of five) quark "mass data" are not in good alignement with the "mass data" of the other particles. The first quark "mass data" lies also outside the straight line. The alignement of this "mass data" could only be obtained at the cost of a hypothetical increase in the "d" mass by 20 MeV. The first lepton (neutrino) and boson (photon) masses are nuls and are well aligned in these log-log coordinates. This allows us to deduce that all observed first mass of different meson or baryon familly will take place on the aligned fit provided that we do the assumption that the familly contains an hypothetical first member without mass. This is illustrated with pion and proton (purple upper side triangles) in fig.14.

The theoretical possibility to suggest possible heavier particle mass is too imprecise because mainly the log-log scale.

In summary the oscillation symmetry is confirmed, and a new property between different particle masses (bosons and fermions) seems to exist through the Oscillation Symmetry.

[1] B. Tatischeff, "Oscillation symmetry applied to: 1) hadronic and nuclei masses and widths, 2) astrophysics. And used to predict unknown data.", Proceedings of the 15^{th} International Conference on Nuclear Reaction Mechanisms, Varenna (Italy).

[2] Boris Tatischeff, "Application of the Oscillation Symmetry to various theoretical hadronic masses", vixra.org/pdf/2209.0034v1.pdf

[3] Boris Tatischeff, "Connections between Hadronic Masses in the One Hand and between Fundamental Particle Masses in the Other Hand", Journal of Advances in Applied Mathematics **53**, 104 (2020). DOI:10.22606/JAAM.2020.53002.

[4] B. Tatischeff, "Oscillation symmetry applied to some astrophysical masses, and allowing to highlight remarkable relations between masses", Physics and Astronomy International Journal, DOI:10.15406/PAIJ.2020.04.00206.

[5] R.L. Workman et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2022, 083C01 (2022) and 2023 update.