Survey

and

Consequences

PDG Survey on Printed Products

At the 2012 Advisory Committee, we proposed a survey on the future of the Book and Booklet.
(The Diary was discontinued due to budget cuts).

An amazing 6172 readers responded, demonstrating the very high value our community places on PDG products.

(We sent out one email; no reminders).

PDG Survey on Book, Booklet and APP

Comparing surveys in 2000 and in 2014

THE QUESTION: Is having a copy of the full-sized book (booklet) essential to your work or study?

Yes, it is essential.
No, I do not need it.
Having the full-size book is useful, but I could live without it or live with a reduced book.

TOTAL Responses: 2450 in 2000 and 6172 in 2014

Reader Comments: 1226 in 2000 and 1491 in 2014

PDG Survey on Book, Booklet and APP

2000	2014	PREFERENCE FOR BOOK (in %)
9	32.1	Not needed
----	26.1	Satisfied with reduced book (not asked in 2000)
52	23.5	Like but could do without
39	18.4	I need the book

BOOK	BOOKLET	PREFERENCE in 2014 (in %)
32.1	18.5	Not needed
26.1	29.9	Satisfied with reduced book(let)
23.5	18.4	Like but could do without
18.4	33.2	I need the book(let)

Future of Book and Booklet

Book:

a) **Keep book as is** (Where is funding? And how control size to avoid binding issues?)

b) **Discontinue** (Not the preference of 68%)

c) **Reduce content & size** (Still some cost, but perhaps some publisher or funding agency will bear this much reduced cost).

Future of Book and Booklet

Booklet:

a) **Keep booklet as is** (How control size to avoid binding issues?)

b) **Discontinue** (Not the preference of 82%)

c) **Reduce content & size** (Which content? How satisfy readers?).

Booklet

PAGES in Booklet

9	Electroweak Model
7	CKM
5	CP Violation
7	Neutrino Mass…
5	Structure Functions
6	Big Bang Cosmology
15	Passage of Particles through Matter
19	Particle Detectors (accel & non-accel.)
14	Statistics
9	Kinematics

New Higgs and Dark Energy → 1 page each.

Booklet

Issue with Booklet is not cost.

It is the number of pages and eventual binding issues.

Summary Tables grow every edition (and baryon resonances already removed).

Also, it would be nice to reduce pages so ordinary binding could be used.

11. STATUS OF HIGGS BOSON PHYSICS

Written November 2013 by M. Carena (FNAL and the University of Chicago), C. Grojean (ICREA at IFAE, Universitat Autònoma de Barcelona), M. Kado (Laboratoire de l'Accélérateur Linéaire, LAL and CERN), and V. Sharma (UC San Diego).

I. Introduction

The observation by ATLAS [1] and CMS [2] of a new boson with a mass of approximately 125 GeV decaying into $\gamma\gamma$, WW and ZZ bosons and the subsequent studies of the properties of this particle is a milestone in the understanding of the mechanism that breaks electroweak symmetry and generates the masses of the known elementary particles (In the case of neutrinos, it is possible that the EWSB mechanism plays only a partial role in generating the observed neutrino masses, with additional contributions at a higher scale via the so called see-saw mechanism.), one of the most fundamental problems in particle physics.

In the Standard Model, the mechanism of electroweak symmetry breaking (EWSB) [3] provides a general framework to keep untouched the structure of the gauge interactions at high energy and still generate the observed masses of the W and Z gauge bosons by means of charged and neutral Goldstone bosons that manifest themselves as the longitudinal components of the gauge bosons. The discovery of ATLAS and CMS now strongly suggests that these three Goldstone bosons combine with an extra (elementary) scalar boson to form a weak doublet.

This picture matches very well with the Standard Model (SM) [4] which describes the electroweak interactions by a gauge field theory invariant under the $\mathrm{SU}(2)_L \times \mathrm{U}(1)_Y$ symmetry group. In the SM, the EWSB mechanism posits a self-interacting complex doublet of scalar fields, and the renormalizable interactions are arranged such that the neutral component of the scalar doublet acquires a vacuum expectation value (VEV) $v \approx 246$ GeV, which sets the scale of electroweak symmetry breaking.

Three massless Goldstone bosons are generated, which are absorbed to give masses to the W and Z gauge bosons. The remaining component of the complex doublet becomes the Higgs boson – a new fundamental scalar particle. The masses of all fermions are also a consequence of EWSB since the Higgs doublet is postulated to couple to the fermions through Yukawa interactions. However, the true structure behind the newly discovered boson, including the exact dynamics that triggers the Higgs VEV, and the corresponding ultraviolet completion is still unsolved.

Even if the discovered boson has weak couplings to all known SM degrees of freedom, it is not impossible that it is part of an extended symmetry structure or that it emerges from a light resonance of a strongly coupled sector. It needs to be established whether the Higgs boson is solitary or whether other states populate the EWSB sector.

Further discussion and references may be found in the full *Review of Particle Physics*.

26. DARK ENERGY

Written November 2013 by M. J. Mortonson (UCB, LBL), D. H. Weinberg (OSU), and M. White (UCB, LBL).

26.1. Repulsive Gravity and Cosmic Acceleration

In the late 1990s, supernova surveys by two independent teams provided direct evidence for accelerating cosmic expansion [8,9], establishing the cosmological constant model (with $\Omega_\mathrm{m} \approx 0.3$, $\Omega_\Lambda \approx 0.7$) as the preferred alternative to the $\Omega_\mathrm{m} = 1$ scenario. Shortly thereafter, CMB evidence for a spatially flat universe [10,11], and thus for $\Omega_\mathrm{tot} \approx 1$, cemented the case for cosmic acceleration by firmly eliminating the free-expansion alternative with $\Omega_\mathrm{m} \ll 1$ and $\Omega_\Lambda = 0$. Today, the accelerating universe is well established by multiple lines of independent evidence from a tight web of precise cosmological measurements.

As discussed in the Big Bang Cosmology article of this *Review* (Sec. 22), the scale factor $R(t)$ of a homogeneous and isotropic universe governed by GR grows at an accelerating rate if the pressure $p < -\frac{1}{3}\rho$. A cosmological constant has $\rho_\Lambda = $ const. and pressure $p_\Lambda = -\rho_\Lambda$ (see Eq. 22.10), so it will drive acceleration if it dominates the total energy density. However, acceleration could arise from a more general form of "dark energy" that has negative pressure, typically specified in terms of the equation-of-state-parameter $w = p/\rho$ ($= -1$ for a cosmological constant). Furthermore, the conclusion that acceleration requires a new energy component beyond matter and radiation relies on the assumption that GR is the correct description of gravity on cosmological scales.

26.2. Theories of Cosmic Acceleration

A cosmological constant is the mathematically simplest, and perhaps the physically simplest, theoretical explanation for the accelerating universe. The problem is explaining its unnaturally small magnitude, as discussed in Sec. 22.4.7 of this *Review*. An alternative (which still requires finding a way to make the cosmological constant zero or at least negligibly small) is that the accelerating cosmic expansion is driven by a new form of energy such as a scalar field [13] with potential $V(\phi)$. In the limit that $\frac{1}{2}\dot{\phi}^2 \ll |V(\phi)|$, the scalar field acts like a cosmological constant, with $p_\phi \approx -\rho_\phi$. In this scenario, today's cosmic acceleration is closely akin to the epoch of inflation, but with radically different energy and timescale.

More generally, the value of $w = p_\phi/\rho_\phi$ in scalar field models evolves with time in a way that depends on $V(\phi)$ and on the initial conditions $(\phi_\mathrm{i}, \dot{\phi}_\mathrm{i})$; some forms of $V(\phi)$ have attractor solutions in which the late-time behavior is insensitive to initial values. Many forms of time evolution are possible, including ones where w is approximately constant and broad classes where w "freezes" towards or "thaws" away from $w = -1$, with the transition occurring when the field comes to dominate the total energy budget. If ρ_ϕ is even approximately constant, then it becomes dynamically insignificant at high redshift, because the matter density scales as $\rho_\mathrm{m} \propto (1+z)^3$.

Further discussion and references may be found in the full *Review of Particle Physics*.

PDG App(s)

Two thirds of respondents said app was either important or very important. (6172 respondents)

Comments from survey were emphatic:

Reduced printed products are dependent on producing replacement app(s).

PDG App(s)

- ***Summary Tables***

  Basically easy;

  just formatting for readability

- ***Review articles***

  Even easier except for formatting tables

- ***pdgLive***

  Not easy. Major programming to connect to database and to present on-the-fly.

  Proposal to DOE was tabled so far.

Budget

and

Related Issues

PDG Research

Historically, research by PDG members has been recognized as the secret to the success of PDG.

It is the key ingredient that assures that RPP is produced by highly qualified active physicists.

All are only 50% PDG

Juerg Beringer
Dan Dwyer
Cheng-Ju Lin
Simone Pagan Griso
Weiming Yao
Michael Barnett

Extensive Outsourcing

Of 206 authors, six are Berkeley PDG members (not including the 3 unpaid retirees).

Over the past 20 years, PDG has been outstanding in outsourcing everything possible to others in our community.

But there has to be a central organization that:

- coordinates everything,
- drives the schedule,
- assures quality,
- controls the outsourcing, and
- produces the products.

Quality Assurance

Quality control has to be the critical path.
The community relies on us.

This requires central coordination.

With 206 authors, there are <u>many</u> points of failure.
LBNL's job is to oversee all and make sure there is no failure.

Direct and In-Kind Funding

Other funding (national and international).
In-kind contributions and deliverables.

Previous NSF: **Direct funding at proportional level (12%) at scale of products used by NSF-supported people.**

Japan: **Direct funding at scale of those received; In-kind to cover expenses of Japanese members.**

CERN: **Pays for products shipped to CERN and distributed throughout Europe. Funds Meson Team expenses.**

Budget

Funding from DOE + Japan (Japan 6% in FY15)

NSF grant (12% of budget) ended last year.

Due to Congress' continuing resolution, the PDG budget for this year (FY15) has been cut by 11%.

96% of the PDG budget is salary.
In FY15, salary alone is more than our funding during CR.

- **We no longer pay any portion of retiree contributions.**
- **We replaced our full-time admin with a 10% admin.**
  (trying to hire a 1 FTE programmer to replace CD help)
- **All printed products are not currently in our budget.**

This situation is not sustainable.

The End

of budget and personnel

Summary

PDG Staff in Berkeley

Staff for *Review of Particle Physics*

Physicists:

- **6 half-time (3 FTE)**
- **3 retired unpaid part-time**

Editor/physicist

Programmer search underway

Computing Upgrade

20-year-old system replaced.

New capabilities for 21st century.

Hope to produce app(s)

New programmer to implement and maintain upgraded computing system. Additional funds needed to support pdgLive part of app.

DOE Review 2008

"The LBNL core group is considered essential for the success of the collaboration, and its lean and dedicated qualities have been almost universally recognized for some time. … The core LBNL-based PDG group displays exceptional effort and expertise in their many PDG related activities and responsibilities."

NSF Reviewers

"Reviewing the proposal for the PDG is somewhat akin to reviewing motherhood. The services that have been provided by this group to the world community of high energy physicists is of inestimable value. It is carried out with great competence, which accounts for its wide acceptance."

"The work of the PDG is absolutely necessary for rapid progress of elementary particle physics. Without it, the field would be very fragmented and achieving consensus would be very difficult."

"They have anticipated needs of HEP scientists extremely well. The data provided by the PDG is the best I know about in all fields. Everybody in HEP makes use of the review and many scientists outside HEP."

NSF Reviewers

“It would be hard to imagine HEP without it, and I do not know any other group capable of this effort. The group competence and past accomplishments are excellent.”

“The Particle Data Books become "bibles" to researchers in particle physics. Without this work, progress would be slower.”

... an extremely valuable resource to the particle physics community. This effort is invaluable and must be supported. This is constantly being improved and expanded.

PDG Summary

PDG provides a vital, dynamic, innovative service to the HEP community.

The HEP community depends on PDG to provide standards and to assure integrity and quality in summarizing particle physics.

The End

In-Kind

In-kind contributions and deliverables.

- The 196 non-Berkeley PDG authors are all making in-kind contributions, since they are not paid, but work typically 5% time on PDG. Their deliverables are encoding of Data Listings and writing of Reviews.
- The CERN Meson Team has the entire sections on strongly decaying mesons as their deliverable.
- INSPIRE has a deliverable of linking to RPP.
- Mirror sites deliver the mirrors.

But as discussed above, central coordination must remain.