evolves into a coherent determinate heterogeneous whole.

The different stadia in the order of cosmic Evolution are characterised as follows:

(1) The inconceivable, the unknowable, the formless, of which no character can be predicated (चिदान), including Prakṛiti, or the Reals in a state of equilibrium.

(2) The knowable, the empirical universe, cosmic matter of Experience, things as matter or stuff of consciousness (वस्तु),—comprising Mahat, the intelligible Essence of the cosmos, evolved by differentiation and integration within the formless, characterless, inconceivable Prakṛiti.

(3) Individuated but still indeterminate stuff bifurcating into two series—Subject-experience and Object-experience,—comprising on the one hand the indeterminate unity of apperception or the empirical Ego, as the co-ordinating principle of the Subject-series (अभिषिक्त), and on the other hand, the indeterminate material potencies, the subtile vehicles of potential Energy (तत्त्व, तत्त्वमूल), the ultimate subtile constituents of the Object-series (the material world). The previous stadium, the cosmic matter of Experience (विभ्र, वस्तु) evolves within itself,
by differentiation and integration, an individuated but still indeterminate stuff in two co-ordinated series, Subject and Object.

(4) Determinate stuff (विषय) evolved within the indeterminate by further differentiation and integration, viz., in the series of Subject-experience, sensory and motor stuff; and in the Object series, a corresponding atomic matter-stuff actualising the material potencies in the form of specific sensible Energies. The latter includes the different classes of Paramāṇus, the different kinds of atomic constituents of different kinds of gross matter (अधिनिरूप).

(5) Coherent and integrated matter-stuff, individual substances, characterised by generic and specific properties, which however are not rigidly fixed, but fluent being subject to a three-fold change and constantly evolving, (अयस्मिद्विद्विद्विदात्मकः समृष्टि द्वैवचिन्हति पत्रनिः—आयुर्वीच, Sutra 44, Chap. III. सासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासासाः).

(6) And so the cosmic series moves on ascending stages of unstable equilibrium (विन्यासविन्यास), until the reverse course of equilibration and dissipation of Energy
(महाध्वरिखाल and गणाध्वरिखा), which even now constantly accompanies the evolution and transformation of Energy, completes the disintegration of the universe into its original unmanifested ground, the unknowable Prakṛiti.

The order of Cosmic Evolution according to the अय्यस्त्र (Sutra 19, Pada II) is shown below, in a tabular form:—

Prakṛiti, the unmanifested unknowable ground (वृद्धायाकामविद्वत्व)

Cosmic matter of experience (मन्त्र, विद्वत्व)

<table>
<thead>
<tr>
<th>Subject series (अविशिष्ट)</th>
<th>Object series (अविशिष्ट)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuated indeterminate mind-stuff</td>
<td>Individuated but indeterminate matter-stuff</td>
</tr>
<tr>
<td>(unity of apperception, empirical Ego, (अविशिष्ट)</td>
<td></td>
</tr>
</tbody>
</table>

Determinate mind-stuff (विशिष्ट) sensory and motor psychoses, etc. (विशिष्ट, विशिष्ट एवं आदि)

Determinate matter-stuff (विशिष्ट) atomic and molecular constituents of gross matter (परमाणु—अज्ञातसूत्र)
Coherent and integrated matter-stuff (चतुर्विविधायायः संयुक्त: ततः सत् ।)

Individual substances, with generic and specific characters subject to constant change or evolution e.g. inorganic objects composed of atoms or molecules (परमाणुः), vegetable organisms (हृदः), animal organisms (मरीयः) (चतुर्विविधायायः सतः मरीयः हृदः परमाणुक्तिः-व्यासायः, Sutra 44, Pada III.)

तत्व तत्वं संयुक्तं विविधतेऽन्नागशिः, तथा शष्द्रिघ्रयः विविधतेऽन्नागशिः संयुक्तविविधतत्वं परिषान्तकसलिग्निः, तथा तत्वं विविधशः सुव्याहतिः संयुक्तविविधतत्वं विविधशः न विविधशः परं तत्त्वान्तरसत्त्वं सैतान्तुश्च संयुक्तविविधाया तस्माप्रज्ञानार्थम्यायाययते। (व्यासायः, Sutra 19, Pada II.)

N.B.—The usual order given in the Sāṅkhya compendiums is as follows:—Prakṛiti, Mahat, Ahaṅkāra,—and then the bifurcation, viz. II organs sensory, motor and common sensori-motor from Rājasic Ahaṅkāra, and Tanmātras from Tāmasic Ahaṅkāra,—and finally the Paramāṇus of the Sthūla-Bhūtas.

The conservation of Energy (and of Mass)—the transformation of Energy:—

The Guṇas (Reals), though assuming an infinite diversity of forms and powers, can neither be created
nor destroyed. The totality of the Mass (Tamas), as well as of Energy (Rajas) remains constant, if we take account both of the manifested and the unmanifested, the actual and the potential. But the individual products of the evolutionary process, the concrete phenomenal modes resulting from the combined action of the original Mass, Energy and Essence, are subject to addition and subtraction, growth and decay, which are only due to changes of collocation, and consequent changes of state from the potential to the actual, (in other words, from the future to the present and from the present to the past, in a time series,)—changes, which are illusorily ascribed to the Reals themselves. The different collocations of Mass and Energy give birth to the divers powers of things, the various forms of Energy which may be classed as like and unlike; indeed the course of Evolution from the Reals conforms to a fixed law, not only as regards the order of succession, but also as regards the appearance (and mutual relations) of like and unlike Energies. And this transformation is constantly going on,—the course of Evolution is not arrested for a moment.

गुणानु सम्बन्धस्याद्युपातिन: न प्रकाशमयस्य कीयवाच्यस्य अर्जितिरीव चत्वारलाभागवाणस्यस्यस्यस्य: गुणानविनिर्देश: कपिलानायणायांक। एव
प्रत्यवत्तानि (आधार, Sutra 19, Pada II.) परिषालितिकता
गुणानु। सम्बन्धेन गुणानो परिषालितिकतस्याद्। (ibid. Sutra 13, Pada IV.) एने गुणा: गुणानातीतार्थगुणानातीतिगुणिदवादिपातिन:।
(ibid. Sutra 19, Pada II.) परिषालितिकता गुणानु (आधार,
The doctrine of Causation, a corollary from the conservation and transformation of Energy:—the principle of collocation—the storing-up and the liberation of Energy:—

The Sāṅkhya view of causation follows at once as a corollary from this doctrine of the conservation and transformation of Energy. As the total Energy remains the same, while the world is constantly evolving, cause and effect are only more or less evolved forms of the same ultimate Energy. The sum of effects exists in the sum of causes in a potential (or un-evolved) form. The grouping or collocation alone changes, and this brings on the manifestation of the latent powers of the Guṇas but without creation of anything new. What is called the (material) cause or sum of material causes is only the power which is efficient in the production or rather the vehicle of the power. This power is the unmanifested (or potential) form of the Energy set free (व्यक्ततार्थं) in the effect. But the concomitant conditions are necessary to call forth the so-called material cause into activity. When the favourable combination or co-operation of concomitants is wanting, there is no manifestation of the effect. The question is—what is the aid which the concomitant conditions render to the deter-
mination (and production) of the effect existing in potency in its material cause? First there is the merely mechanical view as illustrated by some commonplace examples, e.g., the manifestation of the figure of the statue in the marble block by the causal efficiency of the sculptor's art, or of the oil in the linseed by pressing, or of the grain of rice out of the paddy by the process of husking. In these cases the manifestation of an effect is only its passage from potentiality to actuality, a stadium in the process of evolution from possible (future) existence to actual (present) existence; and the concomitant condition (सङ्करित्वं) or efficient cause (मिलितकारणं), the sculptor's chiselling, the pressing, the husking, is a sort of mechanical or instrumental help to this passage or transition.

These mechanical examples of the Kapila-Sāṅkhya have the merit of simplicity, but the Patañjali-Sāṅkhya brushes them aside, and explains causation on the basis of the conservation and transformation of Energy, advancing it as the liberation of potential Energy existing
stored up in a Guna collocation, (the sum of material causes) the liberation following on the action of the proximate efficient cause, or concomitant condition (निपित्तकारण).

The causal operation of concomitant conditions (efficient causes) lies only in this that they supply a physical stimulus which liberates the potential Energy stored-up in a given collocation. Everything in the phenomenal world is but a special collocation of the ultimate Reals (Energy, Mass and Essence). The sum of (material) causes potentially contains the Energy manifested in the sum of effects; and in the passage from potency to actualisation, the effectuating condition (the concomitant cause,) when it is itself accomplished, is only a step in the evolutionary series, which adds a specific stimulus, and renders determinate that which was previously indeterminate. When the effectuating condition is added to the sum of material conditions, in a given collocation, all that happens is that a stimulus is imparted, which removes the arrest, disturbs the relatively stable equilibrium, and brings on a liberation of Energy (दृष्टानिष्ठिति) together with a fresh collocation (सूक्ष्मविशेषणितम्). अवधिविशेषविशेषसाधृति परसपार्थकी वृहत्तात्: (आस्मान, Sutra 13, Pada IV.) तत्त्व शब्दो गितिः वर्त्तमानीस्वतं सहस्य न च चक्ष्यापितमहे। विद्वान् गितिम पैदापितक्षज्ञ विशेषतुष्कन्ने सहस्य। नापूर्वसन्तर्पम्। (आस्मान, Sutra 12, Pada IV.)
Describing the production of bodies ('organic vehicles') for individual souls, out of matter of Prakṛti, under the influence of their merit and demerit, as concomitant conditions, Patañjali points out that non-material concomitants like merit and demerit do not supply any moving force or Energy to the sum of material conditions but only remove the arrest (the state of relatively stable equilibrium) in a given collocation, even as the owner of a field removes the barrier in flooding his field from a reservoir of water. This description is intended to represent the super-physical influence of non-material concomitants (or causes)-like volition, merit and demerit, etc., but the causal operation of a material concomitant condition is essentially the same;—there is the same reservoir of stored-up Energy in a given collocation,—the same condition of arrest or relatively stable equilibrium,—the same liberation of the stored-up potential Energy which flows along the line of least resistance;—the only difference being that in the case of material concomitants the stimulus which removes the arrest is physical, instead of being transcendental as in the case of non-material causes like will, merit and demerit, etc.

The Vyāsa-bhāshya helps us to a clear mental representation of the details of this process, being perhaps the finest example before Newton of the exercise of a Scientific Imagination, and as memor-
able as any in the whole history of thought containing as it does the theory of potentials as in a nutshell:—As the owner of many fields can irrigate, from a field which is already flooded, others of the same or a lower level, without forcing the waters thereto with his hands, and merely by making an opening in the barrier or dyke, on which the waters rush in by their own force;—or further, as the same person cannot force these waters, or the earthy matters held in solution therein, into the roots of the rice plants, but only removes the obstructive grasses and weeds, on which the fluids of their own power enter the roots;—such is the action of an effectuating condition (निलिपि) added to a sum of material causes or conditions.

निलिपि अभावयुक्त व्रतसंगमं हर्षशिलमः वर्षितयुक्तं । विद्वचतुः (Patanjali Sutra 3, Pada IV.) न हि पर्षोद्विष्टिः निलिपि संगमं वर्षितं विद्धीकः।

Chain of Causation—fixed order. The order of Evolution with the transformation of the Energies follows a definite law. The unalterable chain of causes and effects in the phenomenal world illustrates this fixed order. But though the cosmic order is one and fixed, it comprehends divers series arising from different combinations of the original Guṇas, which constitute subordinate or particular laws of cause and effect. (ममाल परिशालावच व्यः, Patanjali Sutra 15, Pada III.)
What we call the qualities of things are only modes of Energy acting in those collocations. (संरक्षिता, भविष्य: चतुर्विंशति धर्मः—से य भवतवधिशुरुवमस्यन्मन्ममस्य।।
(आयुर्वेद, नृत्र 14, पाद III.) ते खलनी धर्मं वर्णमाण आयुर्वेदः
; चतुर्विंशत्यते: लक्षणम: चतुर्विंशतिलक्षमाणैं
परमांत्यो लक्षणम्।। (आयुर्वेद, नृत्र 3, पाद IV.) And these various Energies are sometimes actual (kinetic), sometimes potential, rising to actuality, and sometimes sublative, subsiding from actuality into sublatency. In fact, the original Energy is one and ubiquitous, and everything therefore exists in everything else, potentialiter (सम्यः सम्बोधकान्तिः), without prejudice to the generic and specific differences of things (वाचनशेषिन सम्यः सम्बोधकान्) Inorganic matter, vegetable organisms, and animal organisms are essentially and ultimately one (कवमात्रो: परिशिष्टिकः रचादिवस्थां आवर्तं हतं तथा आवर्तां अर्कमं आवर्तां
आवर्तं) so far as Mass and Energy are concerned, but the varied forms of Energy and the generic and specific qualities (or properties) of things, which are but modes of Energy, follow a definite unalterable law in the order of their appearance and succession, under conditions of space, time, mode and causality, and hence all effects do not manifest themselves at once (ह्यकाचारविशिष्टसिपालवनम् न खल
सुलबाचारम् चाकाचारमिन्तरः।। नृत्र 14, पाद III., ibid.) यथा धर्मं भवत संधनस्य धर्मं: तथा धर्मं:।। पित्रः पितृवते गयं जगात्मवर्ति
रति धर्मादिविभासम्।। तथा धर्मार्थियामिन्तः गयं जगात्मवर्ति
संधनस्य धर्मादिविभासम्।। पितृः पितृवते गयं जगात्मवर्ति
रति धर्मादिविभासम्।। (आयुर्वेद, नृत्र 15, पाद III.)
Time, Space, and the Causal Series:

A Tānmaṭra (infra-atomic particle of subtile matter) is conceived by our understanding to stand in three relations—(1) position in Space (दिशावस्था), (2) position in the Time-series (कालवस्था) and (3) position in the causal series (सम्बन्धप्रकार).

These three relations are the work of the intuitive stage of knowledge as opposed to the conceptual (गतिप्रभावमांस as opposed to गतिप्रभावमा.)

But this is not the pure relationless intuition of Reality (राशिवचारा निशिक्षण) which may be termed intellectual intuition, but the intuition that imposes its forms on the Real substrate (राशिवचारा निशिक्षण) or in other words empirical intuition. तथा पूर्बांकुश अभिव्यक्तिकेन दिशावस्थानिशिक्षणमाण-बिशिष्टत्वाय व कालिकोऽस्व राशिवचाराभिषेकते। तथापि एकत्रितस्वयंसम विशिष्टताविशिष्टं भुतात्मानात्मेनीदातं समाधिमयायःपवित्रते। (महाभाष. Sutra. 44, Pada 1.)

Infinite Time is a non-entity objectively considered, being only a construction of the Understanding (श्रवणित्वाय) based on the relation of antecedence and sequence, in which the members of the phenomenal series are intuited to stand to one another. These phenomenal changes as intuited by us in the empirical consciousness fall into a series, which the Understanding conceives, as order in Time. The Time-series, then, is a schema of the Understanding for
representing the course of Evolution. The schema of the Understanding supervenes on the phenomenal world as order in time, and hence in the empirical consciousness the Time-series appears to have an objective reality, and to form a continuum. As there is an ultimate and irreducible unit of extensive quantity (विशाल) in the Gunas or infinitesimal Reals of Prakṛiti, which are without constituent parts, so the moment may be conceived as the ultimate and irreducible unit of this time-continuum as represented in the empirical consciousness. A moment therefore cannot be thought of as containing any parts standing in the relation of antecedence and sequence. If change is represented by the Time-series, a moment as the unit of time may be supposed to represent the unit of change. Now all physical change may be reduced to the motion of atoms in Space, and we may therefore define the moment as representing the ultimate unit of such change —vis., the (instantaneous) transit of an atom (or rather a Tanmātra) from one point in Space to the next succeeding point. Even an atom has constituent parts (the Tanmātras), and hence an atom must take more than one moment to change its position. The motion of that which is absolutely simple and without parts from one point in Space to the next must be instantaneous, and conceived as the absolute unit of change.
(and therefore of time, तम.) If this is held to be an irreducible absolute unit, it will follow that what we represent as the time-continuum is really discrete. Time is of one dimension. Two moments cannot co-exist. Neither does any series of moments exist in reality. Order in Time is nothing but the relation of antecedence and sequence, between the moment that is, and the moment that went just before. But only one moment, the present, exists. The future and the past have no meaning apart from potential and sublatent phenomena. One kind of transformation, to which a thing is subject, is that it changes from the potential to the actual, and from the actual to the sublatent. This may be called the change of mark (विकृतिपरिवर्तन) as opposed to change of quality (विषयपरिवर्तन), and the change due to duration or lapse of time (विश्लेषपरिवर्तन). The present is the mark of actuality,—the future, the mark of potentiality,—and the past, of sublatency,—in a phenomenon. Only one single moment is actual, and the whole Universe evolves in that one single moment. The rest is but potential or sublatent.
Vijnana-bhikshu points out that this does not amount to a denial of Time. It means that time has no real (or objective) existence apart from the 'moment'. But the latter is real, being identical with the unit of change in phenomena (वस्तुपरिलक्षण चक्र-वर्णनात). But even this is real only for our empirical (relative) consciousness (व्युक्तिदर्शन), which intuities the relation of antecedence and sequence into the evolving Reals (Gunas), in the stage of 'empirical intuition' (सविष्यारा गिन्निलक्षपण). The 'intellectual intuition' (गिन्निलिङ्गारा गिन्निलक्षपण) on the other hand, apprehends the Reals as they are, without the empirical imported relations of Space, Time and Causality.

Space as extension and Space as position:

Space must be distinguished as Desa (locus, or rather extension) and Dik (relative position). Space (Dik) as the totality of position, or as an order of co-existent points, is wholly relative to the Understanding, like order in time, being constructed on the basis of relations of position intuited by our empirical (or relative) consciousness. But there is this difference between Space-order and Time-order:—there is no unit of Space as position (Dik),
though we may conceive a unit of Time, viz., the moment (चन) regarded as the unit of change in the phenomenal or causal series (परमार्थविद्वान अनुपरमार्थमपरमार्थमाचतुर्ययाच-वीणाविविक, Sutra 51, Pada III.) Spatial position (Different) results only from the different relations in which the all-pervasive अक्ष्य stands to the various finite (or bounded) objects. On the other hand, Space as extension or locus of a finite body, देश (देशाचार), has an ultimate unit, being analysable into the infinitesimal extensive quantity inherent in the Reals (Gunas) of प्राकृति. (प्राकृति-परिपुरुषः-प्राकृति-परिपुरुषः—वीणाविविक। एकी सेवा दिगम्बरिव अधारितार्थ सामाजिक दिगम्बराभावात्। शक्तिवशस्यस्य दिगम्बरिव सवहारात्। कालस्तंभार्थस्थिति: शाक्तिवशस्यस्थिति: तदुपरित्रोषाय। कालाय दिगम्बरिव शिशुव: तन काल: वचनः दिगम्बरी, दिगम्बर अवश्य दिगम्बरिव शिशुव:।

The Causal series.—The relation of Cause and Effect has been already explained. It only remains to add that the category of causality is mediated through the schema of order in Time. The Empirical Intuition first superimposes relations of antecedence and sequence on changing phenomena (the evolving Gunas or Reals) and the Understanding out of these relations creates order in Time. The Empirical Intuition then intuities the phenomenal series of transformations of Energy in this Time-order and in so doing, imports the relation of cause and effect into the course of Nature. (चालायुक्तपरमार्थविद्वान अचतुर्ययाच-वीणाविविक, Sutra 51, Pada III.)
The dissipation of Energy (and of Mass)—their dissolution into the formless Prakriti:—Co-mic Evolution (परिवर्तमा) is a two-fold process, creative as well as destructive, dissimilative as well as assimilative, katabolic as well as anabolic (प्रकृति and सहिष्णुपरिवर्त्म and सहिष्णुपरिवर्त्मा.) In one aspect, there is the aggregation (unequal aggregation) of Mass and Energy, with consequent transformation of Energy, resulting in the creation of inorganic as well as organic matter, and the genesis of worlds. The successive steps of this process may be described as (1) unequal aggregation with storing-up of Energy in a certain collocation, under a state of arrest (i.e. in a state of relatively stable equilibrium), (2) a stimulus removing the arrest, and disturbing the equilibrium, and (3) liberation of the Energy, moving on to a fresh collocation, fresh aggregation, arrest and equilibrium. The process of the world thus moves on from equilibrium to equilibrium, and the result of that process is the development of a coherent determinate heterogeneous whole (विशेष परिवर्त्म, प्रकृतिसंगमवस्तु, प्रकृति-वस्तु) in what is essentially an incoherent indeterminate homogeneous whole (अविषेष.)

But there is a second aspect of this evolutionary process. Unequal aggregations are unstable, there is a constant tendency in things to go back to the original stable equilibrium,
the state of uniform equal diffusion of Reals. This process is called the resolution of like to like (सद्वप्रतिवाल), consisting in assimilation and dissipation, and being the exact opposite of the process of “differentiation in the integrated” which has evolved the Cosmos. The collocations of Mass, Energy, and Essence are always breaking up, and the Energy as well as the Mass, however slowly, however imperceptibly, are being dissipated i.e. dissolved into the original formless Prakriti a state of permanent equilibrium and arrest, from which there is and can be no return, except under the transcendental influence of the Absolute at the commencement of a new creative cycle. Not that there is a destruction of the Mass or Energy, but a dissipation or dissolution into a condition of equal uniform diffusion from which there is no return. This is not the phenomenon of kinetic Energy disappearing and becoming potential or sublatent, for in such cases there is restitution or reconversion by natural means. When this reverse current of assimilation (and dissipation) prevails over the current of dissimulation (and integration), the Universe will disintegrate more and more, until it disappears in the formless Prakriti, its unknowable source and ground. (सत्त्वव तथा बोधको)

The Evolution of matter (तात्वाचिक छत्रिक) :-

The ultimate constitution of Matter is a question of the profoundest interest in the Sāṅkhya-Pātañ-
jala system. Three stages clearly stand out in the genesis of Matter:—(1) the original infinitesimal units of Mass or inertia, absolutely homogeneous and ubiquitous, on which Energy does work, when the original equilibrium comes to an end (सुकुशि—
तामशाग्रस्व), (2). The infra-atomic unit potentials, charged with different kinds of Energy, which result from the action of Energy on the original units of Mass, ( तन्माट्र ), and (3) the five different classes of atoms, the minutest divisions of which gross matter is capable, but which are themselves complex Tanmátric systems ( खाक्षुतपरमाणु.)

The first stadium Bhútádi is absolutely homogeneous and absolutely inert, being devoid of all physical and chemical characters (चपादिमिरसेवुत) except quantum or mass ( परिमिश्थ, परिसाप ); and this admits neither of addition nor of subtraction, can neither be created nor destroyed. The second stadium Tanmátra represents subtile matter, vibratory, impingent, radiant, etc., instinct with potential energy. These potentials arise from the unequal aggregation of the original mass-units in different proportions and collocations with an unequal distribution of the original Energy ( Rajas). ( तन्माट्र कपाई: बि कारणम् हलि धीत खकारणार्यस्मि खुलाणिकमद्विग अभ्यस्त 
पाल संवेत्रमिश्रित एव—खलतीपरसंक्षिप्त तन्माट्रार्थिं च भूमि ).

The Tanmátras possess something more than quantum of Mass and Energy. They possess physical characters, some of them penetrability
(परकार्य); others powers of impact or pressure, others radiant heat, others again capability of viscous and cohesive attraction. In intimate relation to these physical characters they also possess the potentials of the energies represented by sound, touch, colour, taste and smell, but being subtle matter they are devoid of the peculiar forms (विभेद) which these potentials assume in particles of gross matter like the atoms and their aggregates. In other words, the potentials lodged in subtle matter must undergo peculiar transformations by new groupings or collocations to be classed among sensory stimuli,—gross matter being supposed to be matter endowed with properties of the class of sensory stimuli, though in the minutest particles thereof the sensory stimuli may be infra-sensible, (असीधियः तत्तथे अभिसिद्धः) (सचित्रसिद्धः संज्ञायः ते तथा अभिसिद्धः। ते च पदार्थाः: मानवं.रूढःः: अर्थवस्तः संक्षणिधिः प्रजन्या एकहक्षणाः। तथाच माणादिधिधिः अवस्थोंगः अदितिः एकहक्षणाः।)

The Tanmātras, then, are infra-atomic particles charged with specific potential energies,—first, the potential of the sound stimulus is lodged in one class of particles, Tanmātras which possess the physical energy of vibration (परिपक्व), and serve to form the radicle of the ether atom (आकाशपदार्थ), then the potential of the tactile stimulus is lodged in another class of Tanmātras, particles which possess the physical
energy of impact or mechanical pressure in addition to that of vibration and serve to form the radicle of the gas atom (Vāyu Paramānu); next, the potential of the colour stimulus is lodged in a third class of Tanmātras, particles which are charged with the energy of radiant heat and light in addition to those of impact and vibration and serve to form the nucleus of the light and heat corpuscle; then the potential of the taste-stimulus is lodged in other Tanmātras, particles which possess the energy of viscous attraction, in addition to those of heat, impact and vibration, and which afterwards develop into the atom of water, and lastly, the potential of the smell-stimulus is lodged in a further class of Tanmātras, particles which are charged with the energy of cohesive attraction, in addition to those of viscous attraction, heat, impact and vibration and which serve to form the radicle of the earth atom.
Before explaining the genesis of atoms, it is necessary to say something about Aṅkāsa, which is the link between the infra-atomic particles (Tanmātras), and atoms (Paramānus). Aṅkāsa corresponds in some respects to the ether of the physicists, and in others to what may be called proto-atom (protyle). In one aspect Aṅkāsa is all-pervasive (विस्तु), and devoid of the property of impenetrability which characterises even the infra-atomic potential units (Tanmātras). In another aspect, Aṅkāsa is described as having originated out of the mass or inertia in Prakṛiti (Bhūtādi) when the latter became charged with the first potential vibration (the sound-potential). Vijñāna-bhikshu in the Yoga-Vārtika boldly tackles the difficulty. Aṅkāsa, he explains, has two forms, original and derivative, non-atomic and atomic. The original Aṅkāsa is the undifferentiated formless Tamas (mass in Prakṛiti, matter-rudiment—Bhūtādi) which is devoid of all potentials, and is merely the all-pervasive seat or vehicle of the ubiquitous original Energy (Rajas). This Aṅkāsa
must not be confounded with vacuum, which is merely negative (आपरणांत—un-occupiedness), though it must be conceived as all-pervasive, occupying the same space as the various forms of gross matter (सत्तास्वरूपम्—चतुर्ब्रह्मचक्रम् ताकार्व—दीपवार्तिक), and therefore devoid of the property of impenetrability (मूलाञ्चलांनावस्त्रंशसं—दीपवार्तिक) which characterises atomic matter. But when the original equilibrium (सम्बन्ध) comes to an end, unequal aggregations form collocations in different groups and proportions of the three Guṇas. (बुधविखलकर्ण प्रमोदं संयोगविशिष्ट: संख्यनं—दीपवार्तिक, विपरीतभाष्य and दीपवार्तिक). The transformation of Energy now begins,—working on a collocation of mass (with Essence), (बुधविलप-मलकेपदं संकेत:—दीपवार्तिक); it first gives rise to the sound potential (प्रबंधनविकाशयं परिचित्व—दीपवार्तिक) and the atomic Ākāśa (proto-atom, protyle) is but an integration of the original unit of mass charged with this vibration-potential. This vibratory (or rather rotary) ether-atom (आकाश) is integrated, limited (परिचित्व) and as such cannot occupy the same space with other (subsequently integrated) atoms. But this proto-atomic integration of Ākāśa (आकाश) is formed everywhere, and itself residing in the ubiquitous non-atomic Ākāśa (आकाश—परकाश) ; forms the universal medium in which air or gas atoms, light and heat corpuscles, and other atoms move and float about. (बायोरावर्षन बदलिंहि अकाशगुणस्मृत्वाकाश)
The genesis of the infra-atomic unit-potentials (Tanmātras) and of the atoms.

The subject of the genesis and the structure of the Tanmātras and the Paramāṇus was a fascinating one to these ancient thinkers, and a wide divergence of views prevailed. I will here notice several typical views:—those of the Vishnu Purāṇa, Parāśara, Patañjali and a certain School of Vedántists reported in the Tārāṅgaṇḍa.

I. A famous passage in the Vishnu Purāṇa explains the genesis and the structure of the Tanmātras and of the Bhūtas (Paramāṇus) in the following manner:—

The first Tanmātra originated from the rudiment-matter (Bhūtādi), the individuated but still indeterminate potential-less Mass in Prakṛiti, under the action of Energy (उपप्रकृत: परिप्रधान:—प्रथमभाष, Sutra 62, Ch. I.) by a process of disintegration and emanation (विभेदः—विभेदः परिप्रधान:—एकविकाराद्वयः—आयुरभाष, Sutra 14, Pada IV, विकाराद्वधः विविकारात्मानं आयुरभाष: वाच्यता प्रवि
This first subtile matter, the first result of 'Mass-disintegration' and Energy-transformation, is charged with the sound-potential, the potential of vibration or oscillation (परिबार्त). It is called the sound-potential (शब्द सत्य). This is typical of the genesis (and structure) of the other Tanmátrás (kinds of subtile matter). In each of the remaining cases, an atomic Mass charged with actual specific energies (मूलपरमाणु) disintegrates and emanates, and thus evolves a form of subtile matter (a kind of Tanmátra) under the action of Energy, and always in the same menstruum or surrounding medium,—that of Bhútádi, the super-subtile. Each kind of subtile matter becomes charged with a new potential in addition to the potentials already evolved. The genesis of an atom, a Bhúta-Paramánu, is a quite different process. Here the unit potential (Tanmátra) receives an accretion of Mass, and by a sort of condensation and collocation evolves an atom (Bhúta-Paramánu).

The genesis and structure of the Tanmátras and the Bhúta-Paramánus are worked out below:

1. The super-subtile individuated Mass (rudiment-matter (Bhútádi), under the action of the
original Energy (रज्ञा) disintegrates and emanates (विकृति) in the menstruum or surrounding medium (वसार्थ) of Mahat, cosmic super-subtile Mass, and evolves a form of subtile matter (तन्त्र), which becomes charged with the sound-potential (vibration-potential, शक्तिपूर्ति), and is called the unit of sound-potential (महत्तन्त्र).

2. This subtile matter, the Mass, charged with sound-potential, receives an accretion of Mass from the rudiment matter (Bhūtādi) and by condensation and collocation evolves the Akāsa Bhūta, the atomic Akāsa, the proto-atom charged with the specific energy of the sound stimulus (actual vibratory motion.) (यदि भूमांशः भव्य-तन्त्रितानु शक्तिपूर्ति गुप्तमपम् भाकां सत्रणं। तथास च ज्ञातासवत्तन्त्रात्तान्म तिलिब भाकां सत्रणं बन्धते,—योगबांसिक or the Vishnu Purāṇa’s passage, Sutra 14, Pada IV).

3. This proto-atom, the atomic Akāsa, charged with its actual specific energy, again disintegrates and emanates, under the action of the original Energy, and in the menstruum of the rudiment-matter (super-subtile Mass) and thus evolves another kind of subtile matter (Tanmātra) which becomes charged with the touch-potential (the potential of impact or mechanical pressure
(यमोल, वचनावल) in addition to the sound-potential (vibration-potential—परिखण्ड) and is called the unit of touch-potential (खर्मनाभ).

4. Next, this subtile matter, the mass charged with touch (and sound) potential, i.e. with the potentials of vibration and impact, receives an accretion of mass again from the rudiment-matter (Bhútádi) and by condensation and collocation, evolves the Váyu Bhúta, a kind of gaseous matter or air of which the atoms are charged with the actual specific energy of the touch stimulus, i.e. with actual energy of impact in addition to the actual energy of vibratory motion.

5. Next, the atom of Váyu, so charged with the actual specific energy of impact and vibration, again disintegrates and emanates, under the action of the original Energy, and in the same menstruum or surrounding medium of the rudiment matter (super-subtile Mass—Bhútádi) and thus evolves another kind of subtile matter (Tanmátra), which becomes charged with the heat-potential (जीणा—ष्व—heat-and-light-potential) in addition to the impact-potential and the vibration-potential, and is called the unit of colour-potential (छपनकाष).
6. Now this subtile matter, this radiant matter, charged with light-and-heat potential, and also with impact and vibration potential, receives an accretion of Mass again from the rudiment-matter (Bhútádi), and by condensation and collocation evolves the Tejas Bhúta, the light-and-heat-corpusele, which is charged with the specific Energy of the colour-stimulus, i.e. radiates actual heat and light (विकारण) in addition to manifesting the energy of impact (impingency) and of vibration (or oscillation).

7. Next, this atom or light-and heat-corpusele disintegrates, and emanates as before a form of subtile matter charged with the taste potential (रसन्वर्त), in addition to the three potentials already generated, and also with the physical potential of viscous attraction.

8. This subtile matter charged with the taste-potential and with the potential of viscous attraction condenses and collocates as before into the water-atom which manifests the actual specific energies of viscous attraction and the taste-stimulus.

9. The viscous water-atom charged with the actual specific Energy of the taste-stimulus disintegrates, and emanates as before a form of subtile matter charged with the
smell-potential in addition to the four potentials already generated and also with the potential of cohesive attraction.

10. This subtile matter charged with the smell-potential and with the potential of cohesive attraction condenses and collocates as before into the earth-atom, which manifests the actual specific energies of cohesive attraction and the smell-stimulus Vijñāna-bhikshu in the Yo 'a-Vārtika briefly summarises the Vishnu Purāna process as follows:

Bhūtādi as radicle in conjunction with Mahat produces the sound potential which as radicle in conjunction with Bhūtādi produces Aṅkāra, which as radicle in conjunction with Bhūtādi produces the touch-potential, which as radicle in conjunction with Bhūtādi produces Vāyu, which as radicle in conjunction with Bhūtādi produces the colour-potential, which as radicle in conjunction with Bhūtādi produces Tejas and so on.

In this brief summary he does not bring out the force of विक्षयः (the disintegrating process), and the distinction between the genesis of subtile and gross matter (Tanmātra and Bhūta).

यथा प्रमाणिन्य महान्, महता व तथाहृतः।
सूतादिद्द विक्षयः समः तन्मार्गिकं ततः।
II. A famous passage in Parásara takes another view of the genesis and structure of the Tanmátras and the Bhúta-Paramánus. Krishnapáda, in the सार्वस्वत्विबिधान, represents the scheme as follows:

The Tanmátras originate from one another and in one linear series, and each Bhúta originates in a separate line from its own Tanmátra:

| सूर्यदि (Bhútádi) |
|---|---|
| Sound-Tanmátra—as a radicle or centre surrounded or encircled by Bhútádi generates आकाश. |
| Touch-Tanmátra—as a radicle or centre encircled by Sound-Tanmátra with आकाश-atom as a help generates Váyu— |
| Colour-Tanmátra—as a radicle or centre encircled by Touch-Tanmátra with Váyu-atom as a help generates Tejas— |
| Taste-Tanmátra—as a radicle or centre encircled by Colour-Tanmátra with Tejas-atom as a help generates Ap— |
| Smell-Tanmátra—as a radicle or centre encircled by Taste-Tanmátra with Ap-atom as a help generates पृथ्वी. |
The genesis of a Bhūta-Paramāṇu (atom) from the subtile matter of a Tanmātra is not here so simple as in the view of the Vishnu Purāṇa. The latter speaks of condensation and collocation, but in the passage under reference a Tanmātra is supposed to act as a radicle, as the centre of a system, surrounded or encircled by Tanmātras of the immediately higher order in the medium of its own Bhūta.

Thus an atom of Aṅkāsa has the following structure:

An atom of Aṅkāsa

\[ \text{Sb} = \text{Sābda-Tanmātra (vibration-potential)} \]
\[ \text{Bh} = \text{(Bhūtādi)} \]
An atom of Váyu is constituted as follows——
This takes place within the surrounding medium of A'kása.

A'kása

A'kása

An atom of Váyu

Sp=Sparśa-Tanmátra (impact-potential)
Sb=Sábda-Tanmátra (vibration-potential)

An atom of Tejas—heat-and-light corpuscle—has the following structure:—

Váyu
An atom of Tejas

Rp = Rūpa-Tanmātra (light-potential)
Sp = Sparsa-Tanmātra (impact-potential)

and so on.

A Chemist will be disposed to push his chemical processes into the region of subtile matter. He may translate चावरण as a menstruum, and स्वप्नक as a catalytic agent. In this case, an atom of Vāyu will be considered as generated from the impact-Tanmātra as a radicle, in the menstruum of vibration-Tanmātra, with A´kāsa-atoms as a catalytic agent.

चतुर्थं क्रमः—सृष्टि: श्रवणमात्रां जाति, श्रवणमात्रं सृष्टि: जाति, श्रवणमात्रं श्रवणमात्रां जाति, श्रवणमात्रं श्रवणमात्रां जाति, तत: श्रवणमात्र: जाति, तत: श्रवणमात्र: श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, तत: श्रवणमात्र: श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, तत: श्रवणमात्र: श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, तत: श्रवणमात्र: श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, तत: श्रवणमात्र: श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति, श्रवणमात्रां श्रवणमात्रां जाति—and so on. चतुर्थं क्रमः: तत्परवित्तविवरणं कृतपदार्थम्:।

चतुर्थं क्रमं: तत्परवित्तविवरणं कृतपदार्थम्:।

A slight variation of the above view is ascribed to a certain school of Vedantists in the तत्तविकृतवणा.

The scheme may be represented as follows:—

A Bhúta-atom is evolved by integration (condensation and collocation, नृत्तक्षाम्यम्) from the corresponding Tanmātra (subtile matter). This is the same view as that of the Vishnu puráña.
The Tanmátras again evolve from one another in a lineal series as in Parásara's view. But the process of this generation is somewhat more complex. A Tanmátra first disintegrates and emanates in a surrounding medium (a menstruum) of the Tanmátra just preceding it in the order of genesis and with the help of its own Sthúla Bhúta as a sort of catalytic, generates the Tanmátra next in order; e.g., the infra-atomic impact particles (अण्तरयामि) disintegrate or emanate, in a surrounding 'atmosphere' of the vibratory subtile matter (भव्यत्वाय) and then with the help of their own atomic integration Váyu, gas, generate the Tanmátra next in order, the subtile matter of radiant light-and-heat (तेजः).

III. Patañjali's view, as expounded in the अव-भाष्य and बोगवास्त्रित्र राज्य is as follows:—

(a) The order of genesis of various forms of subtile matter (potentials):—

(i) Bhútádi, the rudiment-matter, original Mass, acted on by Rajas, Energy, produces the sound-potential (vibration-potential) पञ्च-भाष्यम् बहुऽरावस्त्रित्र सवतेन्द्र स्वाम राज्याद्राहः बववार्तीतिपि।

(ii) This subtile vibration-potential, as a radical, with accretion of rudiment-matter...
(Bhútádi) condensing and collocating, and acted on by Rajas, generates the subtle touch-potential (impact-potential) which is impingent as well as vibratory (oscillating).

(3) This subtle impact-potential again, as a radicle, with accretion of rudiment-matter (Bhútádi) condensing and collocating, and acted on by Rajas, generates the subtle light-and-heat potential (हवनन्वात्) which radiates light-and-heat, in addition to being impingent and vibratory.

(4) Next, the light-and-heat potential, as a radicle, with accretion of rudiment-matter, (Bhútádi) condensing and collocating as before, generates the subtle taste-potential, which is charged with the potential of the taste-energy, and of viscous attraction, in addition to being vibratory, impingent and radiant.

(5) Lastly, the subtle taste-potential as a radicle, with accretion of rudiment-matter as before, condensing and collocating, generates the subtle smell-potential, which is charged with the potential of the smell-energy, and also of cohesive attraction, in addition to being vibratory, impingent and radiant.
The order of genesis of the Bhúta Paramánus, (forms of atomic matter).

The five classes of atoms are generated as follows:

1. The sound-potential, subtile matter, with accretion of rudiment-matter (Bhútádi) generates the A'kása-atom.

2. The touch-potentials combine with the vibratory particles (sound potential) to generate the Váyu-atom.

3. The light-and-heat potentials combine with touch-potentials and sound-potentials (i.e. with impact particles and vibratory particles) to produce the Tejas-atom.

4. The taste-potentials combine with light-and-heat potentials, touch-potentials and sound-potentials (i.e. with radiant, impinging and vibratory particles) to generate the Ap-atom and

5. The smell-potentials combine with the preceding potentials (i.e. with particles of touch-energy and with radiant, impinging and vibratory particles) to generate the earth-atom.

The A'kása-atom possesses penetrability, the Váyu-atom impact or mechanical pressure, the Tejas-atom, radiant heat-and-light, the Ap-atom, viscous attraction, and the Earth-atom, cohesive attraction.
Vijñāna-bhikshu in one passage gives the following scheme of the genesis of the Bhūtas:


of Ākāra = Bh(Sb)

of Vāyu = { Bh(Sb) } (Sp)

of Tejas = { Bh(Sb) } (Sp) Rp

where Bh = भूत, Sb = श्वसनमात्र, Sp = ग्यायनमात्र, Rp = प्रसन्नमात्र, and so on.

Bhūtas and Paramānus—Cosmo-genesis and its successive stages.

The 'five Bhūtas' stand for a classification of substances on the basis of their generic properties resulting, as the Sāṅkhyaśas hold, from the structural type of their constituent atoms—a classification more physical than chemical, or properly speaking chemico-physical, unlike the purely chemical classification of the so-called elements of modern chemistry. A Paramānu, again, is a type of atoms corresponding to each Bhūta class, and indeed one and the same kind of Paramānu may
comprehend atoms of different masses, if only these should agree in their structural type.

Cosmo-genesis—a bird’s eye view:—Out of the all-pervasive rudiment-matter (Bhūtādi) appeared Aṅkāsa (ether), first as a Tanmátra (subtile matter) charged with the potential energy of sound (vibration-potential), and then as an atomic integration of a mono-Tanmátric structure (the Aṅkāsa-atom —वायुर्भित्तिः) also ubiquitous and all-enveloping. In the next stage we find a new kind of Tanmátras, systems of the infra-atomic vibratory particles, so arranged as to manifest a new form of energy, that of impact or mechanical pressure and these Tanmátras (वायुर्भित्तिः) combining with the vibration-potentials (Aṅkāsa Tanmátra) produced a new kind of atom, the di-Tanmátric Váyu-atom, which by aggregation formed a gaseous envelope composed of impinging (driving) vibratory particles (Váyu). Next appeared the third class of Tanmátras, infra-atomic systems of the impinging vibratory particles, which by their collocation developed a new form of Energy—the energy of radiant heat-and-light. These Tanmátras (तेजस-वायुर्भित्तिः) combining with the potentials (Tanmátras) of vibration and impact, produced a new kind of atom—the tri-Tanmátric Tejas-atom, the light-and-heat corpuscle, which by aggregation enveloped the gaseous world in huge flames. In the next stage we have the fourth class of
Tanmátras, new and complex infra-atomic systems of the radiant impinging vibratory particles, which evolved the energy of viscous attraction as well as the potential Energy concerned in the taste-stimulus. These Tanmátras (रसस्नामापि) combining with the three previous ones, gave rise to another class of atoms, the tetra-Tanmátric Ap-atom, and the flaming gases were thus precipitated into cosmic masses of viscous fluid matters (Ap). Finally appeared the fifth class of Tanmátras infra-atomic systems of the viscous radiant impinging vibratory particles which developed new forms of Energy—the Energy of cohesive attraction, as well as the potential energy concerned in the stimulus of smell. These Tanmátras (गण्यस्नामापि) uniting with the other four kinds of infra-atomic subtile particles, formed another class of atoms, the penta-Tanmátric Earth-atom. Thus the viscous fluid matters were condensed and transformed into the Earth-Bhúta, comprising the majority of the so-called elements of chemistry.

The Puránas, in their own fanciful way, conceive that, in the course of cosmic evolution, each succeeding Bhúta appeared within an outer envelope of its immediate predecessor, with a total mass (or volume?) a tenth less than that of the latter.
Examples of the different Bhūtas:—

1. Ākāsa. This is ubiquitous.

2. Vāyu. Various substances composed of di-Tanmátric atoms,—kinds of Vāyu—must have been formed in the gaseous envelope in the second stage of cosmic evolution, out of the proto-atoms of Aṅkāsa. But they have either suffered a fresh transformation into substances of a more complex atomic structure, or have dissipated into the mono-Tanmátric Aṅkāsa, out of which they took their rise. The one familiar example now surviving is atmospheric air. Water-vapour (वाप) is but water (Ap), and smoke, fumes, etc. but earth-particles in gaseous diffusion.

3. Tejas:—Various classes of Tejas corpuscles,—substances with tri-Tanmátric atomic structure, i.e. two grades subtler
than the ordinary elements of chemistry (which are of a penta-Tanmātric structure),—are even now known. (तेजो छोलादि—भेंतेन वक्तावधं। भौमं दिब्यं छोलं बासरां—वर्तवर्तुम्,—तस्क्तवर्भाण्य.)

First, there is fire, or the light-and-heat emitted by the burning log of wood or lamp (आच्छि:—दीय:—भौमं तेज:). Now it is important to note that the flame of a burning log of wood (दृश्य) or an oil-lamp is not pure Tejas, a pure mass of light-and-heat corpuscles. There is chemical union with Earth-particles (particles of the hard penta-Tanmātric substance) acted on by Energy; and then the Tejas corpuscles, light-and-heat particles which are latent (absorbed) therein, come forth as flame (पारिक्षोपस्मे नवनि नवनि तेजः अम्बिनेति—विन्दान्मिषु—प्रश्रमभाष्य, Sūtra 110, Chap. V.) Then there is the light of the sun and the stars (दिब्यं सौरं चादिखादि) which are flaming masses of molten viscous matters (जलमाणवनं तेजः दिब्यं तच्छराधि,—तस्क्तवर्भाण्य, आच्छितङ्गकमः) or of molten earthy matters (क्षूर्योदितं सब्जोंशि तेजः पारिक्षोपस्मः—वक्त्राद्य अवस्थितार्न,—विन्दान्मिषु, प्रश्रमभाष्य, Sūtra 13, Chap. III.) There is also the lightning, which liberates a kind of Tejas latent in the aqueous particles and vapours, under the action of
Energy, in the same way as an ordinary fire liberates the Tejas latent in the wood or other fuel. Next there are the stores of animal heat derived from the break-up of the nutritive material. Lastly there comes the peculiar form of the Tejas Energy (radiant Energy) stored up in the metalliferous ores and igneous rocks which have been formed in the subterranean heat. Here Earthy matters are mixed up, but the radiant Energy predominates in the composition of the metals.

Aniruddha, a late Sānkhya commentator, notes in reference to ‘igneous bodies’ that the greater part of their mass is derived from the Earth-Bhūta, though the Tejas particles determine the peculiar chemical combination, which produces them; and this must also be his view of the composition of the metals.

4. Ap. This viscous fluid of a tetra-Tanmātric structure has but one pure example, viz, water, though the various organic acids, the juices of fruits and the saps of plants, are supposed to be transformations of watery radicles combined with different kinds of earthy accretions.
5. Lastly the Earth-Bhúta, the hard full-formed matter, with its penta-Tanmátric atoms, comprises by far the majority of the so-called chemical elements.

The question is,—how does one and the same Bhúta, of the same formal structure, comprise different kinds of elements, with different atomic masses, and different characteristic properties? And the answer is not far to seek. The properties of a thing are only the energies that are manifested in the particular collocations of the three Guñas,—Mass, Energy and Essence; and a tri-Tanmátric, or a penta-Tanmátric atom, i.e. an atom composed of three or of five kinds of Tanmátras may differ from another of the same class, in respect of the number of constituent Tanmátras of any particular kind, as also of their collocation or grouping, and therefore in mass as well as in generic and specific characters.

The Sánkhya-Pátañjala conceives the properties (or energies) of substances to result from the grouping or the quanta of the Tanmátras, or the Guñas themselves, and hence any radical differences in substances of the same Bhúta class must characterise their atoms, though in an inassensible form. In the Nyáya-Vaiseshika, on the other hand, the atoms of the same Bhúta class are alike in themselves, homogeneous; and the variety of substances comprehended under the
same Bhûta, is ascribed merely to the different arrangements or groupings of the atoms (सूक्ष्म) and not of their components, for components they have none.

As a typical and familiar instance of the variety of characteristic properties (or energies) that may result from variations in accompaniment or grouping, the Sânkhya-Pátañjala points to the various kinds of fruit acids and juices, all originating from one and the same Bhûta (water) with different accretions of earthy matters (पूर्विकार: ). In the same way, though we speak of only five classes of Tanmátras and atoms, the infinite variety of the world results from the infinitely varied collocations of the three original Gunas, which underlie Tanmátra and atom alike (सत्त्रक्षेत्र: अभयमः काहचालः).

वंशात्: परमाणुरितः—आश्वासितः, चयोऽयोर, reporting the Sânkhya view: अक्षुन्निश्चापन: वंशात्: परमाणुरितः—आश्वासितः, Sútra 44, Pada III.—परमाणु: हारान्यायमेवंहः

अक्षुन्निश्चापन: दस्तानुगतः समुद्रायः—आश्वासितः, Sútra 44, Pada IV,—गोर्गार्जनैविकः धार्मिकः शक्ति: भवः (ibid, Sútra 14, Pada III.) वो धनम्, अनुपाली

सामान्य:—यथं एवादमां गुणां अनेकर्मा प्रकृति:—

प्रकट अथ विपर्यायः: शविष्णु। यथा वारिद्र्यस्युज्ज्वल ज्वलन

एवर्त्त्वः शक्ति शविष्णु विपर्यायः, आयामा नारिद्र्यस्माध्य:मीमांसा—
If we take a unit of rudiment-matter (Bhútádi) for the unit of mass (cf. the mass of an electron with a charge of motion etc.), and represent the first Tánmátra by \( t \), such units, and if further, \( t_2 \), \( t_3 \), \( t_4 \), \( t_5 \) units of mass (Bhútádi) be successively added at each accretion to form a fresh Tánmátra, then the second, third, fourth and fifth Tánmátras will respectively contain \( t_1 + t_2 \), \( t_1 + t_2 + t_3 \), \( t_1 + t_2 + t_3 + t_4 \), and \( t_1 + t_2 + t_3 + t_4 + t_5 \) units of mass.

Also the Váyu atom (bi-Tánmátric system) will contain \( t_1 + (t_1 + t_2) \), i.e. \( 2t_1 + t_2 \) units of mass; the Tejas-atom (tri-Tánmátric system) will contain \( t_1 + (t_1 + t_2) + (t_1 + t_2 + t_3) \) i.e. \( 3t_1 + 2t_2 + t_3 \) units; the Ap-atom (tetra-Tánmátric system) \( t_1 + (t_2 + t_3) + (t_1 + t_2 + t_3 + t_4) \), i.e. \( 4t_1 + 3t_2 + 2t_3 + t_4 \) units; and the Earth-atom (penta-Tánmátric system), \( t_1 + (t_1 + t_2) + \ldots + (t_1 + t_2 + t_3 + t_4 + t_5) \), i.e. \( 5t_1 + 4t_2 + 3t_3 + 2t_4 + t_5 \) units.

If \( t \) units of mass be added to the first Tánmátra to form the atom of \( \text{A'kása} \), the latter will contain \( t_1 + t \) units of mass.
In other words, the numbers representing the mass-units (Tamas) in the different classes of atoms (gross matter) will form an ascending series, viz., \( t_1 + t, \ 2t_1 + t_2, \ 3t_1 + 2t_2 + t_3, \ 4t_1 + 3t_2 + 2t_3 + t_4, \) and \( 5t_1 + 4t_2 + 3t_3 + 2t_4 + t_5. \)

Now if a follower of the Sánkhya-Pátañjala were asked to account for differences among Paramásus of the same Bhúta class, he would perhaps suppose \( t_1 \) to vary from \( \alpha_1 \) to \( \beta_1, \) \( t_2 \) from \( \alpha_2 \) to \( \beta_2, \) \( t_3 \) from \( \alpha_3 \) to \( \beta_3, \) \( t_4 \) from \( \alpha_4 \) to \( \beta_4, \) and \( t_5 \) from \( \alpha_5 \) to \( \beta_5. \)

Therefore the mass-units contained in the Váyu-atoms of the different possible Váyu substances would be represented by \( 2\alpha_1 + t, \ 2\alpha_1 + 1 + t, \ 2\alpha_1 + 2 + t, \ldots \ldots \ldots \ldots 2\beta_1 + t, \) in A. P. with unity as common difference, there being \( 2(\beta_1 - \alpha_1) + 1 \) possible Váyu substances.

The mass-units contained in the Tejas-atoms of the different possible Tejas substances would be represented by the series, \( 3\alpha_2 + 2\alpha_2 + \alpha_3, \ 3\alpha_1 + 2\alpha_2 + \alpha_3 + 1, \ldots \ldots \ldots 3\beta_2 + 2\beta_2 + \beta_3, \) increasing in A. P. by unity as common difference, then being \( 3(\beta_2 - \alpha_2) + 2(\beta_2 - \alpha_3) + (\beta_2 - \alpha_3) + 1, \) Tejas substances possible.

The mass-units contained in the Ap-atoms of the different possible Ap-substances would form the series \( 4\alpha_3 + 3\alpha_3 + 2\alpha_3 + \alpha_4, \ 4\alpha_3 + 3\alpha_3 + 2\alpha_3 + \alpha_4 + 1, \ldots \ldots \ldots 4\beta_3 + 3\beta_3 + 2\beta_3 + \beta_4, \) there being \( 4(\beta_3 - \alpha_3) + 3(\beta_3 - \alpha_4) + 2(\beta_3 - \alpha_4) + (\beta_3 - \alpha_4) + 1 \) Ap-substances possible.
The mass units contained in the Earth-atoms of the different possible Earth-substances would form the series in A. P., \[ 5\alpha_1 + 4\alpha_2 + 3\alpha_3 + 2\alpha_4 + \alpha_5, \]
\[ 5\alpha_1 + 4\alpha_2 + 3\alpha_3 + 2\alpha_4 + \alpha_5 + \alpha_6, \]
\[ \ldots \] there being \( 5(\beta_1 - \alpha_1) + 4(\beta_2 - \alpha_2) + 3(\beta_3 - \alpha_3) + 2(\beta_4 - \alpha_4) + (\beta_5 - \alpha_5) + 1 \) Earth-substances possible.

Size (परिमाण).—As to size or volume, the Sāṅkhya accepts only two kinds—the infinitesimal, which is also without parts (कृतः—निर्वक्त) and the non-infinitesimal, which consists of parts (क्षयः—बायति). The latter varies from the excessively small (the so-called Anus, Tanmātras and Paramānus) to the indefinitely great (क्रमविधु—विन्,—e.g.—Aṅkāsa).

The Guṇas alone are infinitesimal, with the exception of those ubiquitous ones that evolve into Aṅkāsa-atoms and Mind-stuff (अक्षमात्राः, and अन्न:-करण) :—all the rest of the evolved products (whether subtle or gross matter) are non-infinitesimal.

Vijñānabhikṣhu notes that all the Guṇas (Reals) cannot be ubiquitous. If this were the case, that disturbance of equilibrium, that unequal aggregation with unequal stress and strain, with which cosmic evolution begins, would be impossible. The Guṇas, which give rise to Aṅkāsa and Mind-stuff, must be held to be ubiquitous, and this will suffice for the ubiquity of Prakṛti.
Chemical analysis and Synthesis—Elements and Compounds.

What then is the equivalent in the Sánkhyā-Pátañjala of the distinction between a chemical element and a chemical compound, or is there none? Did or did not this elaborate physical analysis and classification of things lead on to a classification based on chemical analysis and chemical synthesis? These are questions of singular interest, the answer to which will disclose some new points of view from which the ancient Hindu thinkers approached the problems of chemical physics and physical chemistry.

Aggregates (समूहः) may, in regard to their structure, be divided into two classes, (1) those of which the parts are in intimate union and fusion, being lost in the whole (अधुनविष्कार्यः समूहः); and (2) mechanical aggregates, or collocations of distinct and independent parts (धुनविष्कार्यः समूहः).

A substance is an aggregate of the former kind, and may be divided into two classes, (1) the Bhūtās and their ‘isomeric’ modifications (धूम, भूतवैद्य and बहुविकार); and (2) chemical compounds (विभिन्नरूप,
Chemical compounds again may be subdivided into two classes, (1) those composed of atoms of the same Bhūta class, i.e. of different isomeric modifications of the same Bhūta, and (2) those composed of atoms of different Bhūta classes. In the first case, there is contact between ‘isomeric’ atoms (एकालोकः-संबोगः), in the second case between heterogeneous or ‘polymeric’ atoms (विज्ञानीय-संबोगः). The first contact leads to intimate union (सम्प्रज्ज्वलीः-संयोजनविभेदः संयोगः दृष्टान्तः विज्ञानीयीयविभेदः विज्ञानकोषाः प्रवचनसांक्षेपः) : the isomeric atoms by a peculiar liberation of Energy (एकालोकः—the action of similars on similars) are attracted towards one another, and being riveted as it were, form the so-called material cause (विश्राम कारणः) of the compound product. The second kind of contact (that between unlike or ‘polymeric’ atoms of heterogeneous Bhūtas) begins with a liberation of Energy (उपदेशः), which breaks up each of the Bhūtas, and taking particles (or atoms) of one as nuclei or radicles groups particles of the rest round these radicles in a comparatively free or unattached condition. In this case, one Bhūta, that which serves to furnish the radicles, not necessarily that which is numerically or quantitatively predominant, gets the name of material cause (विश्राम कारणः), and the others, which by their collocation cause the liberation of Energy (उपदेशः, उपदेशः or विनिष्यः).
are called efficient causes (विनिः चारण) — एकस्य-द्वाभाना मध्यां दुस्य चारणां अत्यधिक आद्यांशां निद्वासात् भेदान्त् तमान् तत् बशि—वाष्पातिक, नौपदी on Kārikā 16. The illustrations given (viz. the Rānas as modifications of Ag, water, with Earth-accretions) show that this process applies not only to the Guṇas, but also to the Bhūtas. यथा आद्यांशादिवर्षा वानरं पालयां वानालयां वंशवातानि विद्युते—(नौपदी on Kārikā 17).—वल सति (सौभाग्य-पाठार्पी जापि) वचनादिवर्षेणाधिष्ठायतानि पालायवे सनक—सोगम (अनिव्रत on Śūtra 112, Chap. V), आद्यांशादिवर्षा चारणां वंशवातानि साहिवानन्त विद्युतानि वानरां दशि: एकस्य द्वाभानां दुस्यां योगानं जापित। (विद्युतानि—पालनाति)

Aniruddha goes so far as to hold that both ‘isomeric’ and ‘polymeric’ (or ‘heterogenic’) combinations are real cases of constitutive contact. (साधोभास्तं शंकौ, e.g. द्वाभानां दुस्यां वंशवातानि—वानिरह on Śūtra 113, Chap. V.) But in the later Sāṅkhya-Pātañjala the current teaching denied this—वशान्त पादानाशानां (Śūtra 102, Chap V), when विद्वान्—विनिः notes—वानरां विनिः भौतिकालाणं चीादानां तद् इति विद्वान्

But besides these transformations of substance (दुस्यां चारणां—पादानां) by ‘isomeric’ or ‘heterogenic’ process, ceaseless changes go on in the characters, the modality, and the states of substances—changes
which are due to the unequal distribution of force
(or of stress and strain,—pressure) among the
Gunas, which are in themselves constant. (भवानी-
वद्यान्ता: वधानं; वद्यान्तक:.—चक्र एका रद्धा शम-
क्षाने प्राण दमक्तने द्वेष, पवालेखाने, दण्डाभेद स्थि-
तो नाचा अथवा इत्या व रद्धा वेठ्णे,—पुराणमहते दत्ति
दण्डानि विलामृक्षयु:—तायमय, सूत्र 13, पाद 11).

“Even as the same figure ‘1’ stands for a
hundred in the place of hundred, for ten in the
place of ten, and for a unit in the place of unit.”

* This conclusively proves that the decimal notation was
familiar to the Hindus when the Vyāsa-Bhāṣya was written,
i.e. centuries before the first appearance of the notation in
the writings of the Arabs or the Greco-Syrian intermedia-
tories. Vāchaspati, who comments on the Vyāsa-Bhāṣya,
composed his Nyāya-Sūchī-Nibandha in वस्त्रवन्दपरे
i.e. Samvat 898 or 842 A. D. This cannot be S’aka 898,
for apart from the decisive use of वाद्युत, which by this time
had come to signify the Samvat era, Vāchaspati’s commen-
tator, Udayana, wrote the Lakshana-vaḵi in S’aka 906—

तत्त्वांयनिर्वाचनित्वित्व: निर्माण; ।
त्त्वांयक्तुग्नां न द्वियोऽविप्रमाणी।

and Udayana, who wrote the Parisuddhi on the Tātparyya-
tikā of Vāchaspati, could not have been a contemporary of
the latter, as will also appear from the invocation to Saras-
vatī in the opening lines of the Parisuddhi. Vāchaspati
then preceded Udayana by 142 years, and must have been
himself preceded by the author of the Vyāsa-Bhāṣya by a
Now the question is—in these mixed substances does the fusion take place by Paramāṇus, or by larger masses (or lumps)? Now a Paramāṇu is defined to be the smallest portion of any substance which exhibits the characteristic qualities of that substance,—in other words, it stands for the smallest homogeneous portion of any substance. It is not without parts and therefore not indivisible. It is subject to disintegration. In a Bhūta or its isomeric modification, the Paramāṇu, the smallest homogeneous component particle, is unmixed, and therefore corresponds to the atom of modern chemistry. In a mixed substance (संयुक्तवात्) whether it is an ‘isomeric’ or a ‘polymeric’ compound, the qualities are due to the mixture, and therefore its Paramāṇu, the smallest homogeneous particle possessing its characteristic qualities, must result from the mixture of the Paramāṇus (in smaller or larger numbers as the case may be) of the component substances. The Paralonger interval still, for Vāchaspati ascribes the Bhāshya to Veda-Vyāsa himself (देहभाष्यसे भाष्यसे भाष्य बिठायराये). The internal evidence also points to the conclusion that the Bhāshya cannot have been composed later than the sixth century,—cf. the quotations from Pañchasikha, Vārshaganyā, and the Shāśthi-Tantra-Sāstra, without a single reference to Iśvara-Krishna—which is decisive. I may add that I remember to have come across passages of a similar import in Buddhist and other writings of a still earlier date.
mánu of a mixed substance therefore corresponds to what we now call molecule. (यसावन्तमेवः दृष्टः परमात्मन्ति—वायुक्तम्। वोह सि नं सर्वेण्यमालानस्य परिच्छेदे व: अभासपर्यं नवर्माणेः—
वाचस्पदि—तत्कथे पारशरी—सूत्र 52, पदा III.—ताथा—
विज्ञानानि न निभौगलः। द्रव्योपरिवर्तते: ज्ञापरात्तुरि विशारि—
अंग्वारं पश्चिमात्रेषु पद्यकर्णैव भाषाकारिभुवेऽवृ व: विशारि—
विज्ञानानि—प्रवचनमाथः, सूत्र 88, चाप. V.)—That the
Paramánus form molecules (द्रव्यक्तम्) in forming
substances, is acknowledged by the Sánkhyas as will
appear from Gaudapáda,—तथा ज्ञानोपवाधवाक्ष द्रव्यं—
कवितुकम्। (गौडापाद, on Káriká 12). Even the Vaisé-
shikás, with their prejudice against 'polymeric' or
'heterogenic' combination, acknowledge that in
'polymeric' compounds the different Bhúta-
substances unite by their Paramánus (or atoms ),
though they rigidly insist that in such cases only
one atom should be regarded as the 'radicle'
(तेजस्विन्य or द्रव्यार्थक कारक) and the others as
co-efficient causes (विभिन्त कारक—उपदक्त, e.g. प्रमेय—
पाद—एवं स्बुन्धंतरं, चतुर्व ज्ञापुर्तेन, बहुविक्ष्याभिधम्मान्तः—
नैत्रेश्योऽभूतम्: पार्थिवपरमात्त्यविभौत्यो तत्रर्क्षित्यते—
पदाति (परमलक्ष्यमाथः—where S'éridhara notes मात्वावा
अवत्तम उपव्ययः and Udayana नैत्रेश्यान्त परमात्वम् नां
पार्थिवपरमात्त्यायामेवः विरूपण्युग्मश्च)।
It is only in the mediaeval Sānkhya-Pātañjala that under the influence of the Nyāya-Vaiseshika doctrine a radical difference was conceived to exist between the structure (or constitution) of a molecule composed of ‘isomeric’ atoms, and that of one composed of heterogeneous (or “polymeric”) atoms. In the former case, there was believed to take place intimate union (सूद्र), in the latter case, only a grouping of comparatively free or loosely attached atoms round a radicle atom (कूर्म), with liberation of Energy (उपहल, अवहल—or विहल) and the setting up of unequal stress and strain (एषस्मक्विन्ह—ट्रांगुरल). At the same time, it was of course admitted that this distinction does not apply to the forms of subtile matter (Tanmātra—सूक्ष्म) which could unite in intimate fusion, whether homogeneous or heterogeneous. For example, the subtile body (सूक्ष्म—वर्तीर) which is supposed to be the seat or vehicle of the conscious principle is acknowledged by Viññāna-bhikshu to be penta-Bhautic (पञ्चबुतात्सव); in other words, all the five Tanmātras serve as material causes, though the gross body (the animal organism) is stated to be only a “polymeric” compound with the Earth-Bhūta as radicle or base.
and 12, Chap. III.—*सण्क्योऽर्थोऽर्थस्तितिः सः
जान्यतः पञ्चाशेषाः* (ibid. Sûtra 19, Chap. III.)

But in the original Sánkhya-Pátañjala it appears that the production of a new substance by mixture of unlike Bhūtas (विज्ञातोऽवप्पोन) was conceded as freely as in the Vedánta, and was conceived as nowise differing from the formation of a compound of atoms of the same Bhūta class. The Sánkhya analysis of all change into transformations of Energy due to collocations of unchanging GUNAS, in other words the prevailing chemico-physical (or physical) point of view, naturally recognises no distinction between collocations of 'isomeric' and those of heterogeneous (or 'polymeric') atoms. At bottom they are all collocations of the GUNAS. Even Vijnána-bhikshu who, as one of the latest expounders of the Sánkhya-Pátañjala, has been most affected by the Vaiseshika prejudice against 'polymeric' combination (विज्ञातोऽवप्पोन) urges that the qualities of a compound substance are not necessarily the result of similar qualities in the component elements. (सण्क्योऽर्थस्तितिः सः पञ्चाशेषाः
जान्यतः पञ्चाशेषाः* रत्स वनेयं (ता-विज्ञाता) चास्ति न िरतः: !)

Elsewhere he explains that far from the vital activity being independent it is originated and maintained by the combined operation or fusion of the different sensory and motor reflexes of the living
organism, and notes that the united operation of mixed (or miscellaneous) causes, where there is a fit collocation of matter, offers no difficulty to a follower of the Sánkhya-Pátañjala: — (तु वानिष्ट्रम् अ संधिसंज्ञान्, सामप्रोपश्यने वचि खण्डेरसपि इत्यदि: 
एषद् एकाभ्यन्तरनाथमे चाक्षात् प्रक्षलि—प्रवचनमाख, Sútra 32, Chap. II.) In the middle of the ninth century, we find Váchaspati instancing some ‘heterogenic’ or ‘polymeric’ compositions as typical examples of evolutionary change (परिशार) and unhesitatingly accepting the substantive character of the products. In the Kaumudi he describes the various acids and juices of fruits as modifications of the same original water in the presence of different kinds of earthy accretions. The process is peculiar. The water-particle (or atom) serves as a radicle or centre of a system, and the different kinds of the Earth-Bhúta centering round this as a nucleus become the seat of forces, which bring in the development of new energies (and new qualities, e.g. tastes) in the water. (यथा वाष्पद्रविष्लितं वेदं एकमेव तत्तत्त्व- 
भूमिकारान्त चाक्षात् गार्डेन-नाथी-विद्यार्थि-रसतयं 
परिशारान्त चुरुक्सुब्धप्रसालंतकुकः विकस्यते। इति 
एकाभ्यन्तरनाथयान्त प्रवचनम् अर्थात्तो चाक्षात् अप्रवचनम्: परिशार- 
वाष्पद्रविष्लितं प्रवचनम्: (कौमुदी on Kárliká 16). Váchaspati also points out that different substances may be transformed into one and the same substance (e.g.
the production of salt by the cow, the horse, the buffalo and the elephant, thrown into the salt factory of Sambara in Rajputana or of the flame of a candle by the combination of wick, oil and fire. (पद्मनाभिकृत् चक्षुमालिका एकः परिशालः तद्वसच गवारक्षस्माताप्रानं सहारितिच्छानं एकवश्चालजातीयवर्णम् परिशालः, परिशेषलानाचार्यं व प्रदीप द्विते।—तत्त्व-वैशारदिः on व्याख्या, Pada IV. Sūtra 14.)

Earlier still, i.e., not later than the sixth century, the Vyāsa-Bhāshya, noting that inorganic matter, vegetable substances and animal substances do not differ from one another essentially in respect of their potential energies and ultimate constituents, points out that various bi-Bhautic chemical compounds of water and earth substances, in the shape of saps, acids and juices, are found in plants in their different parts. (सबध्योऽपरिपालिक्षः ऋषाधि-वैतस्यमक्षारवेष्टम् द्रव्यम्.) In other words, bi-Bhautic compounds are here placed in the same category as ‘isomeric’ compounds of substances of the same Bhūta class, for here the particles of both the Bhūtas are regarded as forming the matter (material cause—वर्णार्थकर्ष) of the smallest homogeneous portions of the compound substances.

N.B.—Vāchaspati naturally interprets this to mean separate modifications of the two Bhūtas.
The view of the earlier Sāṅkhya that atoms of different Bhútas may chemically combine to form molecules of compound substances as much as atoms of different modes of the same Bhúta comes out clearly in Utpala’s brief reference to the Sāṅkhya system in his commentary on Varāhamihira’s Vṛihat Samhitā. (एत्यादेशायः पञ्चम्: [सवामेि: ] पञ्चमंश्च-पूर्तानि समवति। तेथैः गरीरिर्श्च गरीरराशिः। वतः पञ्च- 
मालास्वल्पवानि मालाश्रिः (Utpala, Chap. 1, Śloka 7).

Chemistry in the medical schools of ancient India:—As a matter of fact, long before the fifth century, probably as early as the first century A.D., the prevailing schools of medicine and surgery which were based on the Sāṅkhya teaching with a methodology derived from the Nyāya-Vaiseshika doctrine (cf. Charaka, Sārīrasthāna, Chap. I, Vimānasthāna, Chap. VIII—also Susruta, Sārī- 
rasthāna, Chap. I) had founded an elaborate theory of inorganic and organic compounds, which equally admitted iso-Bhautic and hetero-
Bhautic combinations. Like the Vedantists, Charaka and Susruta held that each of the gross Bhútas (Māhābhútas) is a peculiar ultra-chemical 
compound of five original subtile Bhútas. In this sense, every substance is penta-Bhautic, but for purposes of chemical analysis and synthesis, i.e. 
considered with reference to the Māhābhútas, all substances in their chemical constitution, belong to
one or other of the following classes: Mono-Bhautic, bi-Bhautic, tri-Bhautic, tetra-Bhautic, and penta-Bhautic. Compounds of different Bhūtas, again, may combine to form more complex substances, and these in their turn, higher compounds still, and so on in progressive transformation, as is more specially the case with organic substances and products.

Physical characters of the Bhūtas: The prevailing physical characters of the different Bhūtas and their isomeric modes areenumerated as follows.

Earth-substances—Heavy, rough, hard, inert, dense, opaque, exciting the sense of smell.

Ap-substances—Liquid, viscous, cold, soft, slippery, fluid, exciting the sense of taste.

Tejas-substances—Hot, penetrative, subtle, light, dry, clear, rarefied, and luminous.

Vāyu-substances—Light, cold, dry, transparent, rarefied, impinging.

Ākāsa-substances—imponderable (or light), rarefied, elastic, capable of sound (vibrations).

(युक्त खर बटिष गन्ध खिराविकारेकाज्ञ गजी धारण पार्थिवारि। द्रष्य खिउ ग्रीष गन्ध बट विभिन्न वदरलक्षण)
Charaka points out that the primary qualities or specific physical characters of the five Bhūtas are tactile qualities, *i.e.* sensible to touch, *e.g.* hardness (or roughness) for Earth, liquidity (or yielding to pressure) for Ap, impelling or moving force (pressure) for Vāyu, heat for Tejas; and Vacuum (non-resistance, penetrability) for A'kāsa.

(Charaka-S'ārīrasthāna, Chap. I).

(cf. the elaborate enumeration of physical characters quoted in Vijñāna-bhikshu, Yoga-Vārtika, Sūtra 42, Pada I;—also Varavara's commentary on Tattva-traya, Achit-prakarana).

The Mahā-Bhūtas—mechanical mixtures:—Susruta notes that each of the gross Bhūtas (Mahā-bhūtas) is found mixed up with the other Bhūtas; *e.g.*, the Mahābhūta A'kāsa is the receptacle (or vehicle) of air, heat-and-light, and water vapour; the Mahābhūta Vāyu, of water-vapour, light-and heat, and even fine particles of Earth held in
suspension; the Mahábhúta Tejas, of earth-particles in the shape of smoke, and also water-vapour.

(Charaka, Sústrasthána, Chap. I.)

Mono-Bhautic Earth-substances:—Charaka and Susruta regard the following as Earth-substances—

Gold, the five Lohas (silver, copper, lead, iron and tin) and their 'rust', arsenic, orpiment, various mineral earths and salts, sand, precious stones. (Charaka, Sústrasthána, Chap. I. Cf. also Susruta, Sústrasthána, Chap. I.)

Susruta mentions the alkalis, borax, natron, Yavakshára (carbonate of potash) etc.

Of these Earth-substances, some were known to be compounds, e.g. the chemical salts of the metals, collyrium etc. Susruta describes the preparation of the metallic salts. The leaves of the metals were pasted over with the salts, and then
roasted (चक्कालि) (Chikitsāsthāna, Chap. 10). These metallic salts are therefore mono-Bhautic Earth-compounds. Susruta also gives the preparation of mild and caustic alkalis. (Sūtrasthāna, Chap. 11).

Ap-substances, simple and compound:—

Susruta, following Charaka, enumerates various classes of Ap-substances (द्रवद्रव्य) as follows:—waters, acids, milks, curds, butters, oils (vegetable as well as animal), fats, honeys, molasses, alcoholic liquors, urines etc.

Pure Ap (Mahābhūta) is tasteless and the six tastes are developed when the Mahābhūta Ap enters into combination, mechanical or chemical, with other Mahābhūtas. Susruta notes that various kinds of Earths are dissolved in the waters of different localities, and where the particles so dissolved are predominantly Earthy, the water tastes acid or salt,—where predominantly watery, the resulting taste is sweet,—where the Earth particles are mixed up with Tejas, the water tastes pungent or bitter etc. Such is the case with mechanical mixtures. In the case of bi-Bhautic or tri-Bhautic compounds Charaka mentions that substances with Mahābhūta Ap predominating in their composition taste sweet; with Mahābhūtas Earth and Tejas predominating, acid; with Mahābhūtas Ap and Tejas predominating, salt; with Mahābhūtas Vāyu and Tejas predominating, pun-
gent; with Mahábhútás Váyu and Ákára predominating, bitter; and with Mahábhútás Váyu and Earth predominating, astringent. (Charaka, Sūtras-śthánā, Chap. 26,—cf. Susruta, Sūtras-śthánā, Chap. 42).

In fact with the exception of Susruta’s waters, which are mechanical mixtures, or rather solutions, all these Ap-substances are organic products and, as such, penta-Bhautic, i.e. compounded of all the five Mahábhútas, and the particular ‘taste’ which is developed depends on the relative proportion of the Mahábhútas, and the predominance of one or more of them in the penta-Bhautic compound in question.

Qualities of Compounds.—The isomeric modes of each Mahábhúta have specific colours, tastes etc. due to their structure, i.e. the arrangement of their atoms, and the physico-chemical characters of compounds whether of the same or of different Mahábhútas result from the collocation in unequal proportion of the different forces latent in the atoms of the component substances. Charaka adds that the varied forms (textures) and colours of organic substances, whether vegetable or animal, are derived in the same way.
Susruta ignores Charaka's distinction between Mahabhuta and subtle Bhuta, and views every substance as in reality penta- Bhautic, and it is only the relative predominance of a particular Bhuta or Bhutas in any substance that determines its class. (पृष्ठभूतं जोवाय ग्रास्ताकणं सबु- तावतः दृढः भूमिकिर्तिः। सत्तुमवे स्वभूतावन्ति भवति रद्दं परिचितं द्वारं साधं द्वारं तेजस्वी। द्वारं वाचमं रद्दं ब्यासायोगार्थिः। Susruta, Sutratthana, Chap. 41).

The extant Charaka and Susruta—Succession of medical authorities:—

The extant Charaka and Susruta, the sources of our present information regarding the progress of scientific knowledge in the medical schools of Ancient India, are both redactions of original authorities. The extant Charaka is a redaction by Dridhabala of the genuine Charaka Samhitā, which was itself a redaction by Charaka of the original work of Agnivesa, the disciple of A' treya Punarvasu as distinguished from Krishnātreya and Bhikshu A' treya, also well-known medical authorities. The extant Susruta is a redaction by Nāgarjuna of an original work (Vreddha Susruta) by Susruta, the disciple of Dhanvantari. That Charaka preceded Susruta is almost certain. Nāgarjuna was probably earlier than Dridhabala. This Nāgarjuna is believed to have been the author of a commentary on Patanjali's Mahābhāshya (vide
Bhojavṛitti and Chakrapāṇi), and was probably identical with the alchemist Nāgārjuna (Siddha Nāgārjuna), the metallurgist Nāgārjuna (author of a treatise on metallurgy, Lohāsāstra), and the Buddhist Nāgārjuna, author of the Mādhyamika sūtravrītti. Charaka and Susrūta continued to receive additions after Dridhabala and Nāgārjuna, and even after Vāgbhata, but the whole of the extant Charaka is probably much earlier than the commentator Chakrapāṇi, and the whole of the extant Susrūta earlier than Dalvana, the commentator, and Mādhava, the author of Rūgvinischtaya. The extracts in Vāgbhata make it certain that the passages I have quoted or shall quote from the Sūtrasthāna and Sārīrasthāna of Charaka and Susrūta cannot be later than the sixth century of the Christian era.

Preparation of Chemical Compounds.—The knowledge of chemical compounds and of their preparation continued to make progress in the Charaka and Susrūta Schools. The great metallurgist, Patañjali, in his treatise on Metallurgy (वोष्पराख्य) gave elaborate directions for many metallurgic and chemical processes specially the preparation of the metallic salts, alloys and amalgams, and the extraction, purification and assaying of metals. Probably it was Patañjali who discovered the use of the mixtures called Vidās, which contained aqua regia or other mineral acids
in potentia. Unfortunately Patañjali’s *magnum opus* appears to have been lost, but extracts from it are frequently found in mediæval works on Medicine and Rasáyana, which leave no doubt as to its remarkable scientific value. The metallurgist Nágárjuna advanced the knowledge of chemical compounds by his preparations of mercury. The Harshacharita, in the seventh century, relates a fable concerning this Nágárjuna, and speaks of him as a friend and contemporary of Sátaváhana. The relative priority of Patañjali and Nágárjuna is a vexed question in the history of metallurgy. That Nágárjuna’s Lohasastra was earlier than the final redaction of Patañjali will appear from the following circumstances:—(1) Chakradatta in his summary of Nágárjuna mentions that the chemical process of testing pure iron must be repeated twice before it can be regarded as decisive, whereas Śívadāsa Sen’s extract from Patañjali shows that the latter directed the process to be repeated seven times; (2) Patañjali in the Abhraka-vidhi (mica operation) adds mercury, which in this particular operation is wanting in Nágárjuna’s recipe (cf. Chakradatta, and Patañjali as reported in the Yogaratnákara-samuchchaya); and (3) Nágárjuna is quoted in the earlier compilations, Patañjali in the later.

Early in the sixth century, Varáhamihira in the *Vṛhat Samhitā* gives several preparations of
cements or powders called Vajra-lepa, "cements strong as the thunderbolt;" and there was ample use for these in the temple architecture of the Buddhist period, the remains of which bear testimony to the adamantine strength of these metal or rock cements. (Mahabharata, Chapter 56, Ibid.). Varāhamihira also alludes to the experts in machinery (वल्लकर्त्ते, वल्लकर्त्ता:) and the professional experts in the composition of dyes and cosmetics (रागवनभिषिन्द: Ch.16, also Ch.15). I would also refer to the interesting Chapter on cosmetics (Ch. 76) where Varāhamihira gives various recipes for artificial imitations of natural flower scents as of the essence of Vakula, Utpala, Champaka, Atimuktaka &c., arranges compound scents in a sort of scale according to the proportions of certain ground essences used in their preparation, and determines by the mathematical calculus of combination (कोष्ठकशार) the number of variations of the different notes in this scale. To these classes of professional experts were due three of the great Indian discoveries in the chemical arts and manufactures which enabled India to command for more than a thousand years the markets of the East as well as the West and secured to her an easy and universally recognised pre-eminence among the nations of the world in
manufactures and exports:—(1) the preparation of fast dyes for textile fabrics by the treatment of natural dyes like Manjishtha with alum (तुःशिं माँजिष्ठा रागविनी) and other chemicals (e.g. sulphate of iron) also cow-dung (cf. the "cowdung substitute", Roscoe); (2) the extraction of the principle of indigotin from the indigo plant by a process which however crude is essentially an anticipation of modern chemical methods; and (3) the tempering of steel in a manner worthy of advanced metallurgy, a process to which the medieaval world owed its Damascus swords. It was this applied chemistry much more than handicraft skill which gave India her premier position in the middle ages and earlier (indeed from Pliny to Tavernier) in exports and manufactures; for in handicraft skill as in design and workmanship, great as were her merits, India came to be surpassed by her disciples China and Japan.

The Vásavadatta and the Dasakumára Charita in the sixth century allude to the preparation of a mass of fixed or coagulated mercury (पारजस्कन्द स्वाधायपदिन:—वासवदत्ता); a chemical powder, the inhalation of which would bring on deep sleep or stupor (वोगस्कूळ—प्रक्षमार्गरित); a chemically prepared stick or wick for producing light without fire (वोगवस्तिका—प्रक्षमार्गरित); and a powder which like anaesthetic drugs or curare, paralyses
sensory and motor organs (सच्चासूचक सन्धिवायणम्—पाश्चात्या—धीर्मिकसन्धिवायणं द्विते: ). Vrinda (circa 950 A. D.) notices the preparation of sulphide of mercury (रक्षत्वधीर्मिक) composed of one part of sulphur, and half its weight of mercury; and also of cuprous sulphide (परिंतिताम्). Chakrapāni (circa 1050 A. D.) mentions the preparation of the black sulphide of mercury, “by taking equal parts of mercury and sulphur”.

The Rasārnava (circa 1200 A. D.) notices the colours of metallic flames, probably after Patañjali; e.g. copper gives blue flame;—tin, pigeon-coloured; lead, pale; iron, tawny; blue vitriol, red. It may be noted that the Rasārnava regards mercury as a penta-Bhattic substance.

The Rasaratna-samuchchaya divides the mineral kingdom (Earth-substances, simple and compound) into the following classes:— (1) The eight Rasas, mica, pyrites, bitumen, blue vitriol, calamine, etc. (2) The eight Uparasas (useful in operations of mercury), sulphur, red ochre, green vitriol, alum, orpiment, realgar, collyrium, and medicinal earth, to which may be added the eight Sādhārana Rasas, sal-ammoniac, cowrie, cinnabar, rock vermillion, etc. (3) The gems, diamond, emerald, sapphire, cat’s eye, sunstone, moonstone, pearl, etc. (4) The metals,
gold, silver, iron, copper, lead, tin, and the alloys—brass and bell-metal. Other Earth-substances are six salts, three alkalis, mineral earths, and several poisons (cf. vol. I, pp. 32–98).

Chemical compositions and decompositions—metallurgic processes.—In these writings, we frequently come across instances of chemical composition and decomposition, by processes, more or less crude, of calcination, distillation, sublimation, steaming, fixation, etc. (वनस्पति, खच्छ, राजस्व, सिंदूर, सिंदूरक, ब्रह्मक, खगृणम्) e.g. the preparation of perchloride of mercury by taking common salt and mercury (रससंयोग—वारदी चेतावक्षिप्त), of sulphide of mercury (सिंदूरम्) by taking sulphur and mercury, of Sindúra from lead (विनयु नागरकावल्—Amarakosha);—of the medicinal compounds, Svarnasindúra and Rasasindúra, with mercury, sulphur and gold, where gold may have been fancied to influence the resulting compound in some mysterious way, either as a ‘dynamic’ or as a catalytic;—also the extraction by chemical decomposition of mercury from sulphide of mercury (सिंदूरक, विदे रससंग्रह), of copper from sulphate of copper (सम, सिंदूर) by heating this substance with one-fourth of its weight of borax (Rasaratna-samuchchaya,—cf. Bhávaprakása, तथा...
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... zinc (स्फळ, जस्व) from calamine (सुत्र—Rasārṇava); of copper from pyrites (नालिक, विनाक, etc.—Rasārṇava, (though the golden pyrites were supposed to be a semi-metal of gold, containing some gold along with the essence of copper)—
the purification of mercury by repeated distillation from lead and tin with which it is used to be adulterated in the market. The various metallurgic processes described are—extraction, purification, killing (formation of oxides, chlorides and oxy-chlorides for the most part), calcination, incineration, powdering, solution, distillation, precipitation, rinsing (or washing), drying, steaming, melting, casting, filing, etc. to all which each of the known minerals was successfully subjected by the use of apparatus and reagents and the application of heat in different measures (स्फळ—मखाणपाक— and मन्त्रपाक)—methods which, if often crude, especially from the absence of independent and isolated mineral acids, were yet in several instances remarkably simple and effective, and which, after all by the use of various Vīdas potentially containing mineral acids (aqua regia, sulphuric acid, hydrochloric acid, etc.) virtually accomplished the practical ends kept in view.
To these were added several special processes for mercury (e.g. fixation), bringing up the number of mercurial operations to nineteen.
It may be noted that the mixtures called Vidās, which potentially contained dilute mineral acids, were regularly employed not only in killing the metals (forming their oxides and chlorides), but—what is of fundamental importance—for purposes of chemical decomposition of metallic salts, etc. and the extraction and purification of metals.

Organic Compounds.—Organic Compounds are either vegetable or animal substances. (खावर चाक्रम चूत). The molasses, the fermented liquors, the saps and juices of plants, fruit acids, vegetable ashes and alkalis together with the tissues of plants, are vegetable compounds (चौहिर, खावर चूत). Honey, milk, curd, butter, fat, bile, urine, and other excreta, together with the organs and tissues of animals, are animal substances. Charaka notices vegetable as well as animal oils. The viscous (oily) substances are classed under four heads—butters, oils, fats, and marrows (वर्धलं या भाता वोहो हर्द्वतहप:). Salt may be either mineral or vegetable salt.

Susruta divides poisons into two classes—Vegetable and animal, but several poisons expressly termed mineral poisons (धातुवर्ग) are included in the first class.

All organic substances, whether animal or vegetable, are penta-Bhautic, being compounded
of greater or less proportions of the five Mahábhútas.

Taking the human body Charaka finds that the foetus is composed of sixteen organic substances, viz. four, composing the Sperm-cell which comes from the male; four composing the germ-cell which comes from the female; four added by the transformation of the nutritive material, and finally, four kinds of subtile matter, which together form the vehicle of the conscious principle. As to the four organic substances which compose the sperm-cell, or the other four which compose the germ-cell, it is not clear whether in Charaka’s view they are also in their turn compounded of less complex organic substances, or whether their constituent elements are inorganic penta-Bhautic compounds.

The tissues that appear in the course of development of the foetus are further transformations (higher compounds) of these foetal substances. All the component substances of the body are penta-Bhautic compounds, though sometimes they are assigned to the particular Bhútas which predominate in their composition, e.g. bile to Tejas, lymph, chyle, blood, fat, urine, sweat and other secretions to Ap, and skin, flesh, bones, nails, hair, etc. to Earth. (चुंकं वायुम्यं वृक्षवाणीपादवद् । गर्भं पञ्चारी पद्मविशार्दिगुल्लानि त्वाति हि नातानिचक्षुप्रवानि आकारं-
Fœtal Development (after Susruta). The ovum fertilised by the sperm-cell and developing under the influence of animal heat forms successive layers and tissues, even as layers of cells and fibres are formed in wood. First are formed seven layers epithelial and dermal (श्लेषम्), then follow the several tissues (चक्ष:), the flesh, the vascular tissue, the fat and marrow, the lymphatic (and glandular) tissue, the intestinal tissues, the biliary and the seminal vessels. Tissues which are regarded by some as modifications of the original dermal layers of the ovum (cf. the layers of the blastoderm and their relation to the tissues in Embryology). The tissues are supposed to be developed successively, one out of another, by chemical action or metabolism (प्रज्ञान), e.g. chyle is transformed into blood, blood into flesh, flesh into fat, fat into bone, bone into marrow, marrow into sperm-cell. The organs are next formed out of the tissues.
The liver, gall-bladder (श्रीण), spleen and lungs are referred to the blood; the intestines to the blood, lymph and bile; the kidneys to the blood and fat; the testicles to the blood, lymph and fat; the heart to the blood and lymph; and the tongue to the lymph, blood and flesh. Vāyu, with the accompaniment of animal heat, impels the ‘currents’ (कोटाल्डु) in the system; Vāyu acting on the flesh gives rise to the muscles, and it is Vāyu again, which, with the essence of fat (or marrow), produces the nerves, arteries and tendons. (तत्तै तथा पुलाईस्कन यात्रांशुर इत्यादिका: स्वात्र्वस्य भविष्य।—वक्षः यक्रमय स्त्रा वन्याश्वः। ववाहः सारः वांचेः, सिंहचानेः, वस्त्रते। सत्तै ग्रहवा गंधवति। हीतिया वायुः गहरा। रक्तमणा नेदुत्तता। पुल्लर शोकस्थता। पशुकी गुरीवधरा। चोटी पिसरता। वन्नरी पुमाधरा।—समक्ष विज्ञानात्माः हृदयम्यो।—et seq Susruta, S'arstrathána, Chap. IV.—
रसाँक्ष्य ततो सार्वं सांस्कारोऽहस्ती। गोभिः। नेदुकृष्टिः ततो
मन्ना वष्ण: पुमाः स्वयम्। सुत्रस्थाना, Chap. XIV).

The following parts (tissues and organs) in the foetus are in a special sense modifications of the four organic substances contributed by the sperm-cell of the male parent; hair, nails, teeth, bones, nerves, veins and arteries, tendons and ligaments, and the sperm-cell; the following, of the substances derived from the mother;—skin, blood,
flesh, fat, the heart, liver and spleen, kidneys, stomach, intestines, etc. (Charaka, Sárírāsthāna, Chap. III. चारणि खङ्गोऽर्गः गम्बः/स्पतञ्जाणि-पिितः: सक्ष्रवस्तः
सक्षयानि, पुरुष्यं बेशः-स्त्रु-स्त्रु-श्रील-श्रील-चिन्तासिंहिरा-स्त्रु-
घमम्यं: युक्तमृति विषाधिनी। वागि खङ्गोऽर्गः गम्बः नागाधानि
वागि ओ चल्य नाल्यः: सक्षयानि-तत्रुष्या तत्च ओ
बोधिलखा मांक्यं शेदव्रुद्धं व वकतु ओ मलका ओ रात्रो ओ
पुरीषाधानं ओ क्षाक्यफलं द्राति मागाधानि।)

Chemistry of Digestion—The food we eat contains five classes of penta-Bhaustic organic compounds. From their radicles or predominant elements, the substances are named Earth-compounds, Ap-compounds, Tejas-compounds, Vāyu-compounds and Ākāsa-compounds. The Earth-compounds supply the hard formed matter of the body, the Tejas-compounds give the animal heat (or the metabolic heat), the Vāyu-compounds are the sources of the motor force in the organism, the Ap-compounds furnish the watery parts of the organic fluids, and the Ākāsa-compounds contribute to the finer etheric essence which is the vehicle of the conscious life. Roughly speaking, the Earth-compounds answer to the nitrogen-compounds in the food, the Tejas-compounds to the hydro-carbons (heat-producing) and the Vāyu-compounds to the carbo-hydrates (dynamic). The Ap-compounds are the watery parts of food.
and drink. The flesh, for example, is a tissue composed principally of the Earth-compounds, the fat of the Earth and Ap compounds, the bones of Earth, Vāyu and Tejas compounds. For purposes of digestion it is stated that different operations of the metabolic heat (perhaps different digestive fluids are also meant) are required to digest the different substances in the food.

The course of metabolism is described as follows:—The entire alimentary canal is called Mahāsrotas (the great channel).

The food goes down the gullet by the action of the biomotor force, the Prāna-Vāyu.

In the stomach (आसांम) the food becomes mixed up first with a gelatinous mucus (संचालकप) which has a saccharine taste, and then gets acidulated by the further chemical action of a digestive juice (निधिभुतं गत:—evidently the gastric juice is meant). Then the biomotor force, the Samāna Vāyu, begins to act and drives down the chyle by means of the Grahani Nādi to the Pittāsaya (duodenum), into which bile comes down from the liver, and thence to the small intestines (the साधनक्ष्यां). In these, the bile (or rather the digestive substance in the bile as opposed to the colouring element) acts on the chyme, and converts the latter into chyle (रक्त), which has at first
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a katu taste (pungency). This chyle contains in a decomposed and metamorphosed condition all the penta-Bhaugic organic compounds, viz., tissue-producing Earth-compounds, water parts or Ap-compounds, heat-producing Tejas-compounds, force-producing Vāyu-compounds, and lastly, finer etheric constituents which serve as the vehicle of consciousness. The essence of chyle (क्षिप्र) from the small intestines is driven by the biomotor force, the Prāna Vāyu, along a Dhamanī trunk (cf. the thoracic duct) first to the heart (which is a great receptacle of chyle), and thence to the liver (and the spleen), and in the liver, the colouring substance in the bile acts on the essence of chyle, especially on the Tejas substance therein, and imparts to it a red pigment, transforming it into blood. But the grosser part of chyle (वायु) proceeds along the Dhamanīs, being driven by the biomotor force, the Vyāna Vāyu, all over the body.

When the blood has been formed, the essence of chyle in the blood, acted on by Vāyu (biomotor force) and Mānasāgni (the flesh forming metabolic heat), forms the flesh-tissue, the Earth-compound of the food substance especially contributing to this tissue of the flesh. Tissue thus formed, the grosser part goes to food or replenish the flesh tissue all over the body. The finer essence of flesh in the