

# FRICITION

According to 'MATTER (Re-examined)'

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*Abstract:* Opposition to relative movements between macrobodies in contact is generally termed as 'friction'. Friction develops from the mutual adhesive tendencies of resultant distortion-fields of adjacent atoms on the contact surfaces of macrobodies in contact. All atoms have resultant distortion-fields surrounding their material structures. The tendency of adhesion between interlinking resultant distortion-fields of neighbouring atoms on either side of the contact surface is caused by the merger of these distortion-fields into a common stable structure. An attempt to destabilize the resultant structure of merged distortion-fields between the material bodies in contact results in a resistance to their relative motion.

*Keywords:* Friction, inertia, effort, force

## Introduction:

An alternative concept, presented in the book 'MATTER (Re-examined)' [1], envisages that the entire space, outside basic three-dimensional matter-particles, is filled with an all-encompassing 'universal medium', structured by quanta of matter. Two-dimensional latticework structures by the quanta of matter (called 2D energy-fields) in all possible planes, together, form the universal medium. Structural distortions in the universal medium, in and about a macrobody, are the work associated with it, and a structurally distorted region in the universal medium about a macrobody (or its constituent atom/molecule) is its distortion-field or matter-field. Matter-field includes intrinsic work that sustains the integrity of the body and additional work that sustains the state of the macrobody's state of motion. All conclusions expressed in this article are taken from the book, 'MATTER (Re-examined)' [1]. For details, kindly refer to the same.

## Friction:

Opposition to relative movements, between macrobodies in contact (by rubbing, sliding, rolling, or flowing), is generally termed 'friction'. Here, friction between two solid macrobodies with smooth rubbing surfaces is considered. Smooth surfaces in contact always have a stabilized structure of their matter-fields, normal to contact surfaces (at the contact point), to their common tangent plane. The cause of friction is a combination of atomic/molecular adhesion, surface roughness, and the effects of structural deformation in the universal medium between the contact surfaces.

Surface roughness is a factor when contact surfaces of materials are rough enough to cause serious abrasion on each other. Another occasion for friction is when one or both of the rubbing surfaces are of materials with a relatively soft texture. In this case, much of the resistance to relative movement is caused by structural deformations of the objects. In this article, we shall consider only resistance to relative motion between smooth rubbing surfaces of hard bodies due to atomic/molecular adhesion.

When two macro bodies are in contact, their matter-fields interlink. 3D matter-particles (in atoms/molecules) near the contact surfaces of the macrobodies do not touch each other. However, atoms/molecules in both macrobodies, near the surface of their contact, share structural distortions in each other's matter-field. When there is no relative motion between the macrobodies, matter-fields of

atoms/molecules across the contact surface, together, attain a somewhat stable static condition, sharing each other's structural distortions on either side of the contact. This may cause angular deflections of the atoms/molecules in the macrobodies, which appear as contact electric potential.

Regular movements of subatomic particles in atoms near the surface of contact in both macro bodies, in combination, regulate the structural distortions in the combined region of matter-fields between the macrobodies. A combination of matter-fields of two macrobodies (in addition to the gravitational attraction) gives rise to adhesion and apparent attraction (similar to the Casimir effect) between them. The closer the macrobodies are or the stronger they are pressed together, the stronger the adhesion between them. Many atoms/molecules across the contact surface, from both macrobodies, tend to form natural formations (similar to formations of groups within a macrobody) between them. These atoms/molecules are also under mutual gravitational attraction.

When two macrobodies are in contact, gravitational attraction and field-efforts between the atoms in both macrobodies, across the contact surface, are active. Pressure, if any, by one macro body on the other brings the atoms (across the contact surface) closer to enhance the bond between them. The magnitude of this bond, between the macrobodies, produces a relation between their mutual pressure (weight on each other) and the magnitude of friction between them.

### **Static friction:**

Static friction is the friction between two solid objects in contact that are not moving relative to each other. Latticework structures in the universal medium, across the contact surface between the macrobodies, bear parts of both matter-fields. If one of the macrobodies tends to move sideways relative to the other, latticework structures in their matter-fields across the surface of contact experience shearing tendency. Strain introduced in the latticework structures of 2D energy-fields, by the shearing action, produces an opposing reaction, which tends to prevent relative displacements of the macrobodies. Opposition to this type of relative motion between the macrobodies in contact is 'static friction'.

At any instant, static friction between the bodies (which are static with respect to each other) is equal to the moving effort on the bodies. Work, introduced in association with the body, is neutralized (consumed) by the work in the opposite direction by the bonding efforts between the atoms near the contact surface. No resultant additional work is preserved in the matter-field of the body, and hence the body remains relatively static. Stress developed in the structural formations of the combined matter-fields across the surface of contact provides opposition to relative motion. The magnitude of static friction is modified as soon as a relative motion between the contact surfaces begins.

### **Starting friction:**

The strength of the bond between atoms of macrobodies, across the surface of contact, corresponds to the distance between them. Hence, the strength of the bond between macrobodies (with constant mutual pressure) in contact is maintained at a constant level, whether they are static or moving relative to each other. Bonds between the atoms of the macrobodies across the contact surface act as additional adhesion between the macrobodies. In order to have a relative motion between the macrobodies, external effort has to overcome the opposition produced by this additional adhesion. To commence relative motion, a stable structure of merged matter-fields between the bodies needs to be sheared in the tangential direction. During the static state, additional work needed for their relative displacement was continuously neutralized by the work due to static friction. In order to produce a relative motion, the external force has to overcome the shearing force in the combined matter-field at the contact surface.

The sliding body will commence relative motion as and when the external effort exceeds the highest magnitude of static friction between the bodies. Additional work introduced by an external effort is sufficient to overcome neutralization by static frictional effort. Resultant additional work associated with the body will be in the direction of the external effort and causes the body's relative motion. The presence of a constant magnitude of resultant additional work about the body will tend to move the body at constant relative speed. The magnitude of work required to overcome the highest magnitude of static friction should be more than the opposing work by the shearing effort in the combined matter-field at the contact surface (resistance to relative

motion). This resistance (the highest magnitude of static friction between the bodies in contact) at the commencement of relative motion is the starting friction.

### **Kinetic friction:**

Kinetic (or dynamic) friction occurs when two objects are moving relative to each other and rub together (like a sled on the ground). Kinetic friction is also (sometimes) called the sliding friction or dynamic friction.

Transfer of structural distortions in its matter-field (universal medium about the macro body) produces the macrobody's motion. Movement of a macrobody requires additional structural distortions (additional work) invested in its matter-field by an external effort.

Once the macrobodies have developed relative motion, the inertial properties of the matter-field of the moving body tend to maintain the moving body's relative motion at a linear speed corresponding to the magnitude of additional structural distortions (work) about it. Additional structural distortions (work), introduced into the matter-field of the moving body by an external effort, are transferred in the universal medium at the same speed as the relative translation speed of the macrobodies. The magnitude of the highest static friction (starting friction) between the bodies remains. However, due to the presence of additional work stored in the matter-field of the moving body (invoking inertial property), the effort required to accelerate the body further appears to have reduced. This is understood as a reduction in the magnitude of the highest static (starting) friction between the bodies. Although the magnitude of starting friction has not changed, the apparent magnitude of friction between the bodies has reduced by a component proportional to the linear speed of the body. This apparent magnitude of friction between the bodies is 'kinetic friction'.

Static friction and starting friction are modified to kinetic friction as long as a macrobody is moving at a constant relative speed with respect to its rubbing partner. Only kinetic friction acts between macrobodies in contact and moving at constant relative linear speed to each other and resists further actions by the external effort. The magnitude of kinetic friction is much less than static/starting friction by a factor determined by the magnitude of additional work about the moving body's matter-field. Appearance of reduction in (kinetic) friction is not due to a reduction in the static/starting friction but due to the presence of additional work in the matter-field of the moving body that causes its motion. Additional work associated with the moving body effectively opposes starting friction, and the result is a reduced magnitude of kinetic friction. Should there be a change in the relative linear speed of the moving macrobody, corresponding starting friction reappears until the matter-field of the moving macrobody regains its stability at constant relative linear speed.

### **Heating due to friction:**

During relative motion between two macrobodies in contact, atoms in both macrobodies, across the contact surface, influence each other through their distortion-fields. Structural distortions in the distortion-field of one atom try to enhance or reduce structural distortions in the distortion-field of the other atom, as appropriate to their directions and magnitudes. Variations in the nature and magnitude of structural distortions in the distortion-field of an atom tend to affect the linear speeds of constituent photons in the constituent 3D matter-particles of other atoms in the direction of relative motion of the macrobodies.

(Unidirectional) changes of linear speeds of photons (which are moving in circular paths) cause absorption and rejection of quanta of matter to/from their 3D matter-cores, alternately, every half cycle of photons' spin motion. Quanta of matter, absorbed by constituent photons of the macrobody from the universal medium, (being) at a low rate, do not make appreciable effects. At the same time, quanta of matter, discarded by constituent photons of the macrobody into the universal medium, tend to form photons and radiate away. Photons, radiated from the contact surface between the two macrobodies (under relative movement), produce heating and lighting effects due to friction at the rubbing surfaces.

### **Perpendicular force due to friction:**

The combination of distortion-fields and stabilization of their structural distortions on either side of contact surfaces of a fluid body, moving between two static macrobodies, may produce what appears like a tendency of the static bodies to move towards or away from each other. This may be interpreted as a perpendicular force due to friction.

### Physical aspects of friction:

According to the physical aspects of rubbing/rolling/sliding/flowing surfaces, friction may be classified into various classes.

Resistance to the relative lateral motion of two solid bodies in contact is **dry friction**. Dry friction comprises static friction (between non-moving surfaces) and kinetic friction (between moving surfaces).

Resistance to relative motion between layers within a viscous fluid is called **fluid friction**. It is caused by internal resistance to flow, characterized by the viscosity of the fluid body.

**Rolling friction** is the resistance offered for the rolling motion of a wheel at its contact point on the rolling surface. It is an essential requirement to prevent the wheel from slipping on the surface. It is caused mainly by the roughness/deformation of contact surfaces.

**Lubricated friction** is a case of fluid friction to relative motion between two solid bodies, where a fluid separates two solid surfaces. Lubrication is employed to reduce wear and tear of one or both surfaces of solid bodies in close proximity and moving relative to each other by interposing a lubricating substance between contact surfaces. Applied load on lubricated bodies is carried by pressure generated within the lubricating fluid due to the frictional resistance to motion of the lubricant fluid between the surfaces.

**Skin friction** is the frictional force resisting the motion of a solid body through a fluid. It arises from the friction of the fluid against the outer skin of the object that is moving through the fluid. Skin friction is directly related to the area of the body's surface that is in contact with the fluid.

**Internal friction** resists relative displacement between atoms/molecules forming a solid body, while it undergoes (plastic) deformation. When stress (energy) developed in the resultant distortion-fields between atoms/molecules exceeds the threshold, the body is strained to permanent deformation. If stress is less than the threshold value, atoms/molecules will return to their original alignment, and the deformation of the body disappears.

### Work by friction:

Work required for static friction to rearrange the resultant matter-fields about the atoms at the contact surface is done while the surfaces come in contact. Magnitudes of angular deflections of atomic axes show up as electric potential (static electricity). As long as there is no relative motion, static friction is functional after the contact surfaces are in contact. Work done by frictional efforts is always in the opposite direction to relative motion. It tends to oppose/neutralize work done by external effort in association with the moving macro body.

### Reference:

References are neither reviewed nor edited.

[1] Nainan K. Varghese, 'MATTER (Re-examined)', (2013), <https://www.matterdoc.in>

[2] Nainan K. Varghese, 'Mechanism of motion', [https://www.matterdoc.in/articles/mechanism\\_of\\_motion.pdf](https://www.matterdoc.in/articles/mechanism_of_motion.pdf)

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