FRICTION

According to 'MATTER (Re-examined)'
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Abstract: Opposition to relative movements, between macro bodies in contact, is generally termed as **'**friction'. Friction develops from mutual adhesive tendencies of resultant fields adjacent atoms on the contact surfaces of macro bodies in contact. All atoms have resultant fields surrounding their material structures. Tendency of adhesion between interlinking resultant fields of atoms on either side of contact surface is caused by merger of these fields into a common stable structure. Attempt to destabilize resultant structure of merged fields between bodies in contact results in resistance to their relative motion.

Keywords: Friction, inertia, force

Introduction:

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

Friction:

Opposition to relative movements, between macro bodies in contact (by rubbing, sliding, rolling or flowing), is generally termed as **'**friction'. Here, friction between two macro bodies with smooth rubbing surfaces is considered. Smooth surfaces in contact, always have stabilized structure of their matter-fields normal to contact surfaces (at contact point) to their common tangent plane. Cause of friction is a combination of atomic/molecular adhesion, surface roughness, and structural deformation effects in universal medium between 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 the same is when one or both of rubbing surfaces are of materials with 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 inter-link. 3D matter-particles (in atoms/molecules) near contact surfaces of macro bodies do not touch each other. However, atoms/molecules in both macro bodies, near surface of their contact, share structural distortions in each other's matter-field. When there is no relative motion between macro bodies, matter-fields of atoms/molecules across contact surface, together, attain somewhat stable static condition, sharing each other's structural distortions on either side of contact. This may cause angular deflections of the atoms/molecules in macro bodies, 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 structural distortions in combined region of matter-fields between the macro bodies. Combination of matter-fields of two macro bodies (in addition to gravitational attraction) gives rise to adhesion and apparent attraction (similar to Casimir effect) between them. Nearer the macro bodies are or stronger they are pressed together, stronger is the adhesion between them. Many atoms/molecules across the contact surface, from both macro bodies, tend to form natural formations (similar to formations of groups within a macro body) between them. These atoms/molecules are also under mutual gravitational attraction.

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

Static friction:

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

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

Starting friction:

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

The sliding body will commence relative motion as and when external force exceeds highest

magnitude of static friction between the bodies. Additional work introduced by external force is sufficient to overcome neutralization by static frictional force. Resultant additional work in the body will be in the direction of external force and causes body's relative motion. Presence of constant magnitude of resultant additional work about the body will tend to move the body at constant relative speed. Magnitude of work required to overcome highest magnitude of static friction should be more than opposing work by shearing force in combined matter-field at the contact surface (resistance to relative motion). This resistance (highest magnitude of static friction between the bodies in contact) at the commencement of relative motion is 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 as sliding friction or dynamic friction.

Transfer of structural distortions in its matter-field (universal medium about the macro body) produces macro body's motion [2]. Movement of a macro body requires additional structural distortions (additional work) invested in its matter-field by external effort.

Once the macro bodies have developed relative motion, inertial properties of matter-field of moving body tends to maintain moving-body's relative motion at a linear speed corresponding to magnitude of additional distortions (work) about it. Additional distortions (work), introduced into matter-field of moving body by external effort, is transferred in universal medium at same speed as relative translation-speed of macro bodies. Magnitude of highest static friction (starting friction) between the bodies continues to remain. However, due to presence of additional work, stored about matter-field of moving body, effort required to accelerate the body further appears to have reduced. This is understood as reduction in magnitude of highest static (starting) friction between the bodies. Although magnitude of starting friction has not really changed, apparent magnitude of friction between the bodies has reduced by a component proportional to 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 macro body is moving at a constant relative speed with respect to its rubbing partner. Only kinetic friction acts between macro bodies in contact and moving at constant relative linear speed to each other to resist further actions by external forces. Magnitude of kinetic friction is much less than static/starting friction by factor determined by magnitude of additional work about moving body's matter-field. Appearance of reduction in (kinetic) friction is not due to reduction in static/starting friction but due to presence of additional work in the moving body that causes its motion. Additional work associated with moving body effectively opposes starting friction and the result is reduced kinetic friction. Should there be a change in relative linear speed of moving macro body; corresponding starting friction reappears until matter-field of moving macro body regains its stability at constant relative linear speed.

Heating due to friction:

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

(Unidirectional) modifications of linear speeds of photons (which are moving in circular paths) cause absorption and rejection of quanta of matter to/from their matter-cores, alternately, every half cycle of photons' spin motion. Quanta of matter, absorbed by constituent photons of macro body from universal medium, being at low rate, does not make appreciable effects. Quanta of matter, discarded by constituent photons of macro body into universal medium, tend to form photons and radiate. Photons, radiated from contact surface between two macro bodies (having relative movement) produce heating

and lighting effects due to friction, at rubbing surfaces.

Perpendicular force due to friction:

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

Physical aspects of friction:

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

Resistance to relative lateral motion of two solid bodies in contact is **dry friction**. Dry friction comprises of 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 viscosity of the fluid body.

Rolling friction is the resistance offered for rolling motion of a wheel at its contact point on rolling surface. It is an essential requirement to prevent wheel from slipping on the surface. It is caused mainly by 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 another, 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 lubricating fluid between the surfaces.

Skin friction is frictional force resisting the motion of a solid body through a fluid. It arises from the friction of the fluid against outer skin of the object that is moving through the fluid. Skin friction is directly related to the area of 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 resultant fields between atoms/molecules exceeds threshold, the body is strained to permanent deformation. If stress is less than threshold value, atoms/molecules will return to their original alignment and deformation of the body disappears.

Work by friction:

Work required for static friction to rearrange resultant matter-fields about atoms at the contact surface is done while 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 have come in contact. Work-done by frictional forces are always in opposite direction to relative motion. It tends to oppose/neutralize work done by external force in association with the moving macro body.

Reference:

References are neither reviewed nor edited.

[1] Nainan K. Varghese, '*MATTER* (Re-examined)', (2013), http://www.matterdoc.info

[2] Nainan K. Varghese, 'Mechanism of motion', http://vixra.org/abs/1402.0069

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