APPNDX_I

c_g c‡ei cwiwkó 1-5

cwiwkó 1| BD‡iKv Kwnbx I AwKwgwWm

BD‡iKv (*Eureka,* Greek '*heureka*') cKZ A_ Kv‡j f‡` (rarely) ev nVvr K‡i| PgKc` Awe¯‹vi ev Awe¯‹v‡ii †NvlYv| kãwUi e¨rcwËMZ A_ hvB †nvK bv †Kb ÔBD‡iKvÕ kãwU MxK `vkwbK-‰eÁwbK-MwYZÁ-c‡KŠkjwe` AwKwgwW‡mi (Lx:c 287-212) bv‡gi mv‡_ Av‡ôc‡ô Rwo‡q ‡M‡Q| Kwnbxwu njt wmwmwj Øx‡ci mvBiwKDR bMi iv‡ói ivRv nxi‡Yi m‡›`n n‡qwQj †h Zvi Awb›`¨m›`i ivRgKUwU c‡ivcwi †mvbvi ^Zix bq, Gi mv‡_ i¡cv wgwk‡q †` lqv n‡q‡Q| gKUwU bv †f‡O h_v_ZB i¡cvi Ac`e¨ i‡q‡Q wK bv Zv wbi¡c‡Yi Rb¨ wZwb AwKwgwW‡mi mnvqZv Pvb| Kw_Z Av‡Q †h mgm¨vwU AwKwgwWm‡K GZB Av‡jwoZ K‡iwQj †h memgq GwU Zvi wPšvRMr†K Av"Qb K‡iwQj| GgZve¯vq GKw`b wZwb hLb mvb Kivi Rb¨ RjcY †PŠev"Pvq Swc‡q c‡owQ‡jb, †m mgq nVvrB j¶¨ K‡iwQ‡jb †h †`n R‡j W‡e _vKv Ae¯vq wKQ cwigvY Rj AcmZ nj Avi wZwb †ek nvév †eva K‡iwQ‡jb| G AbfwZ †_‡KB R‡ji ceZv ag Zvi g‡b nVvr K‡iB wSwjK w`j-- L‡R †c‡jb mgv‡Ui mgm¨v mgvav‡bi mÎ, Avi Awe®v‡ii Avb‡›` ÔBD‡iKv BD‡iKvÕ (A_vr †c‡qwQ †c‡qwQ) e‡j wPrKvi K‡i D‡VwQ‡jb|

cKZ A‡_ AwKwgwWm wQ‡jb D`¯wZwe`¨vi (Hydrostatics) RbK| ceZv m¤úwKZ AwKwgwW‡mi Awe®vwiwU nj, eZgv‡b hv ÔAwKwgwW‡mi bxwZ ev mÎ bv‡g cwiwPZ,Õ †Kvb e¯LÊK AvswkK ev cwicYfv‡e Zij c`v‡_ wbgw¾Z Ki‡j †m e¯L‡Êi IRb jvNe n†q _v‡K| GB IRb nv‡mi cwigvY n‡"Q, Zij c`v‡_i g‡a¨ wb‡Ri ¯vb K‡i wb‡Z †h cwigvY Zij c`v_ e¯LÊwU‡K AcmviY Ki‡Z nq wVK †mB cwigvY Zij c`v‡_i IRb|Õ D`¯wZwe`¨vi Dci `ÕL‡Ê iwPZ Zvi 'On Floating of Bodies' AvKi MšwU‡Z i‡q‡Q 19wU cwZÁv (proposition)| ÔBD‡iKv BD‡iKvÕ aŸwbi ga¨ w`‡q AwKwgwWm dwq‡Wi (fluids) ev ce‡ni ceZv-a‡gi †h mviK_v¸wj Awe®vwi K‡iwQ‡jb Zv wZwb Zvi MšwU‡Z 4wU cwZÁvq wjwce× K‡iwQ‡jb `‡kv eQ‡iil Av‡M, hv c`v_ we`¨vi QvÎiv AvRI Awfwb‡ek mnKv‡i c‡o| Zvi G Awe®v‡ii ga¨ w`‡q c`v‡_i NbZ I Av‡cw¶K ¸i"Ë m¤ú‡K cZwZ N‡U|

Ó1. hw` Nb e¯i IRb GKB AvqZ‡bi Zij c`v‡_i IR‡bi mgvb nq Z‡e GB Nb e¯‡K Zij c`v‡_ wbg¾b Ki‡j Zv W‡e hv‡e bv, Avevi wKQUv Ask Zij c`v‡_i Dc‡i †_‡K fvm‡el bv| Ó (cwZÁv 3)

Ó2. Zij c`v_ †_‡K KwVb e¯wU nvév n‡j, e¯wU Zij c`v‡_ m¤úY wbgw¾Z n‡e bv, Gi wKQUv Ask Zij c`v‡_i cô †_‡K Dc‡i †ei n‡q _vK‡e|Ó (cwZÁv 4)

Ó3. KwVb e¯wU‡K A‡c¶vKZ fvix Zij c`v‡_ wbg¾b Ki‡j, GwU Ggb AwksKfv‡e wbgw¾Z _vK‡e †h mgM KwVb e¯wUi IRb Acmwiz Zi‡ji IR‡bi mgvb|Ó (cwZÁv 5)

Ó4. Zij c`v‡_ Zvi A‡c¶v AwaKZi fvix KwVb e¯ wbg¾b Ki‡j GB e¯wU Zij c`v‡_i Zj‡`k ¯úk Ki‡e Ges Zij c`v‡_ cwigvwcZ KwVb e¯wUi IRb Zvi cKZ IRb A‡c¶v Kg n‡e ; GB IR‡bi cv_K¨ Acmwi Z Zij c`v‡_i IR‡bi mgvb| Ó (cwZÁv 7)

AwKwgwWm wQ‡jb BZwji `w¶‡Y wmwmwj Øxc¯ mvBiwKDR bMi iv‡ói Awaevmx Ges †n‡jwbK HwZ‡n¨i ‡kl DËimix‡`i Ab¨Zg I Av‡j·w›`qv †i‡bmvi avi K| wKse`šx †h †ivgK Avµg YKvix‡`i nv‡Z `xN Ae‡iv‡ai ci mvBiwKDR bM‡ii cZb NU‡j, wbwePvi jÉb I nZ¨vKv‡Êi mgq GB wekwek“Z weÁvbx R‰bK †ivgK ‰m‡b¨i nv‡Z wbnZ nb| cPwjZ Kwnbx nj †h †m mgq wZwb Zvi evmM‡n GKwU Mp R¨wgwZK mgm¨v mgvav‡b wbgM wQ‡jb| GwU wbtm‡›`‡n BwZnv‡mi GK ggš` Kwnbx| kni i¶vi Rb¨ wZwb wbgvY K‡iwQ‡jb enr c¯iLÊ wb‡¶cK hwšK cvm, hv †ivgK h× RvnvRmgn‡K A‡K‡Rv K‡i ZjZ; G ai‡Yi cvm hš‡K †mKv‡j ejv nZ K¨vUvcvë (Catapult)| wbgvY K‡iwQ‡jb GK ai‡Yi RwUj KwcKj e¨e¯v hvi GKcv‡š mvowm AvKv‡ii ‡jvnvi AvsUv I PÂwewkó j¤v j¤v Kv‡Vi LwU | G¸wj‡K AwKwgwW‡mi wb‡`‡k bMi i¶v cvPxi Mv‡Î emv‡bv n‡qwQj| LwU¸wj‡K wjfv‡ii mvnv‡h¨ Dc‡i-bx‡P, mvg‡b-‡cQ‡b, I Wv‡b-ev‡q bvbw`‡K Pvjbvi e¨e¯v wQj| kÎ“‰mb¨ †Kvbfv‡e bM‡ii wbK‡U DcbxZ n‡j KwcK‡ji mvnv‡h¨ fwg †_‡K wekvjvKwZi c¯iLÊ D‡Ëvjb K‡i kÎ“‡mbvi Dci m‡Rv‡i wb‡¶c Kiv nZ| A‡bK mgq GB KwcKj¸wj‡K mg`Zxi chš enb K‡i wb‡q j¤v PÂi mnvqZvq wekvj wekvj h× RvnvR‡K gwU‡Z AvQ‡o fvOv nZ| RwUj hše¨e¯wU A‡bKUv AvawbK h‡Mi wekvjvKwZi Ôej‡WvRv‡iiÕ gZ| Gi cvkvcwk R¨wgwZK Av‡jvK weÁv‡bi mÎ e¨envi K‡i wZwb ^Zix K‡iwQ‡jb h‡× e¨env‡ivc‡hvMx weivU AvKv‡ii AeZj-`cb| G ai‡Yi `cb e¨envi K‡i wZwb mhiwk‡K cwZdwjZ I †ivgK RvnvRmg‡ni Dci †K›`xfZ K‡i Av¸b awi‡q w`‡Zb| Gi Av‡M †Kvb ivóe¨e¯v ^eÁwbK chw³‡K Ggb wecjfv‡e h×‡¶‡Î e¨envi K‡i‡Q e‡j g‡b nq bv| †mw`K †_‡K AwKwgwWm‡K Ôh×weÁv‡bi RbKÕ ejv ‡h‡Z cv‡i| DwjwLZ D™vebx Kr†KŠkj QvovI wZwb bvbv ai‡bi hš‡KŠkj wbgvb K‡iQ‡jb hv RbKj¨v‡b e¨eüZ nZ| †hgb ‡mP Kv‡h e¨envi Dc‡hvMx ÔRj-¯‹Õ Zvi D™vebx kwKÍi Ace wb`kb| GQvov wjfvi I wgkcwj e¨envi K‡i bvbv cKvi hš wb¤§vY K‡iwQ‡jb| Gme hš‡KŠkj RvnvR mn fvix e¯ D‡Ëwjb ev bov‡bvi Kv‡R e¨eüZ nZ| Kw_Z Av‡Q wZwb bv wK mgvU wniY‡K e‡jwQ‡jb, ÓAvgv‡K †Kv_vI GKU `vovevi ¯vb †`qv †nvK, Awg †MvUv cw_ex‡K bwo‡q †`e|Ó GiB cgvY ¯i¡c GKevi ivRv wniY wbw¤§Z GKwU wekvj fvix RvnvR‡K AwKwgwWm wb‡R wgkcwji (polyspaston) mnvqZvq `i †_‡K Abvqv‡m I Aejxjvµ‡g Pwj‡q mg`-R‡j fvwm‡q w`‡qwQ‡jb| wZwb gnvKv‡k mh, P›` I cvPwU M‡ni cwiågY eSv‡Z GKwU weivU †MvjK A_vr AvawbK fvlvq c¨vwb‡Uwiqvg ^Zix Kwi‡qwQ‡jb| Gi mnv‡h¨ AvKvkPvix †R¨wZ®†`i cwiµgY MwZ, Ges mh I P‡›`i MnY BZ¨w` wbLZfv‡e `kK‡`i Kv‡Q c`kb Kiv m¤e nZ|

e¯Z AwKwgwWm cvPxbKv‡ji `vkwbK weÁvbxi gZ †Kej Z‡Ëi Ávbiv‡R¨ wb‡R‡K †KvUive× iv‡Lb wb, Zvi g‡a¨ N‡UwQj ZwË‡Ki †gavi mv‡_ †cŠKkj-chw³ cwZfvi mv_K mgšq| ZvB wZwb n‡q D‡VwQ‡jb AvawbK `wófw½‡Z '‡mKv‡ji †kô weÁvbx Ô|

gnvgwZ Av‡jKRvÛv‡ii ¶gZv jv‡fi ciB cvPxb Mxmxq †n‡jwbK mf¨Zv-HwZ‡n¨i cvjve`j NU‡Z _v‡K, †n‡jwbK mf¨Zv-ms¯‹wZi mv‡_ ms‡kl N‡U cv‡P¨i ms¯‹wZ I mf¨Zv| Av‡jKRvÛv‡ii gZ¨i ci Zvi wekvj mvgvR¨ wZbwU AÂ‡j wef³ n‡q c‡o- (1) Aw›U‡Mvwb‡`i AšMZ †gwm‡Wwbqv I Mxm, (2) †mj¨K‡`i kwmZ Gwkq AÂj, Ges (3) U‡jgx‡`i Øviv kwmZ wgki| U‡jgx‡`i Kv‡j wgki wQj MxK weÁv‡bi cavb †K›`¯j| Z‡e GwUB GK gvÎ †K›` wQj bv, †hLv‡bB MxK Dcwb‡ek, Zv Gwkqv‡ZB †nvK A_ev Ab¨Î, ¯wcZ n‡q‡Q ‡mLv‡b G ai‡bi weÁvb PPvi cwi‡ek M‡o D‡V‡Q| ZZxq kZvãx‡Z G ai‡Yi D‡jL‡hvM¨ D`vniY nj wmwmwji wmiwKDR bMi, †hLv‡b AwWKwgwW‡mi gZ cwZfv weKwkZ n‡qwQj| AwWKwgwWm wKfv‡e wmwmwj Øx‡c Dcw¯Z n‡qwQ‡jb ‡m mgqKvi H AÂ‡ji MxK-wdwbmxq-‡ivgvb‡`i g‡a¨ msMVZ msN‡li BwZnv‡mi Af¨š‡i jwK‡q i‡q‡Q, Zv D˜NvU‡bi AeKvk Avgv‡`i †bB|

AwWKwgwW‡mi cwZfv enZj we¯Z- MwYZ, R¨wgwZ, wÎ‡KvYwgwZ, c`v_weÁvb cfwZ bvbv k•Ljv Zvi Ae`v‡b mg¾j| BDwKW hw` meKv‡ji Rb¨ R¨wgwZ kv‡¯i gvb wbwÏó K‡i wM‡q _v‡Kb, AwWKwgwWm wfwË ¯vcb K‡iwQ‡jb ejwe`¨vi I cZwe`¨vi| ÁvbPPvi `vkwbK c×wZ†Z wZwb wQ‡jb BDwK‡Wi Abmvix A_vr hMcrfv‡e eû we`¨vi Abkxj‡bi cwie‡Z ¯ímsL¨K k•Ljvi Dci NbxfZ GKvMwPË Abkxj‡b g‡bwb‡ek I wewkóZv ARb, hv wK bv Av‡j·v›`xq Ávb mvabvi we‡klZ| wÎ‡KvYwgwZ‡Z Zvi c`Ë cvBÛi (π) mwbKó gvb (22/7) Avgiv AvRI e¨envi K‡i _wK| Kv‡ji Kivj _vev †_‡K †e‡P hvIqv Zvi KwZcq M‡ši D‡jL †hvM¨ K‡qKwU nj t

mgZ‡ji mw¯wZ : `B LÊ (On the Equilibrium of Planes, I and II)
Awae‡Ëi cv`ms¯vb (Qudrature of the Parabola)
†MvjK I †ejb (On the Sphere and Cylinder)
mwcj (On Spirals)
k¼m`k I †MvjKm`k Nb (On Conoids and Spheroids)
fvmgvb e¯: `B LÊ (On Floating Bodies, I and II)
e‡Ëi cwigvcb (Measurement of a Circle)
evjKviwRi wnmve (The Sand Reckoner)
÷gwKqb (Stomchion)
R¨wgwZK avav (Geometric Puzzle)
‡jgv msµvš c¯K (Books of Lemmas)
Mi“ mgm¨v (Cattle Problem)

Z‡e A‡b‡Ki g‡Z Zvi wjwLZ '*Method of treating of Mechanical Problems, dedicated to Eratostbenes*' ev ms‡¶‡c Epbodos (method) A_vr Ôc×wZÔ MšwU AwWKwgwWm cwZfvi D¾jZg cKvk| G cm‡½ cvPxb weÁv‡bi BwZnv‡mi ‡jLK RR mvU‡bi gšZe¨ ¯§iY Kiv †h‡Z cv‡i t

Ó... GwU BwZnv‡mi me‡P‡q Ávb D˜NvUbKvix `wjj¸wji Ab¨Zg| Avi GB Ávb †Kej cvPxb weÁv‡bi g‡a¨ mxgve× bq eis mKj h‡Mi mwweK weÁv‡bi †¶‡Î c‡hvR¨| Ó [ cvPxb weÁv‡bi BwZnvm, RR mvUb, evsjv Abev` evsjv GKv‡Wgx, 1978]

cwiwkó 2| Av‡c‡ji Kwnbx I wbDUb

wbDU‡bi c‡iv bvg m¨vi AvBRvK wbDUb (Sir Issac Newton)| AvawbK ejweÁv‡bi (Mechanics) RbK gnvgwZ wbDUb Rb¥MnY K‡iwQ‡jb 1642 mv‡j Bsj¨v‡Ûi Djm‡_vc bvgK cvovMv‡q| wbDUb KËK ga¨vKlY e‡ji ZwËK e¨vL¨v c`v‡bi c‡e A_vr mß`k kZvãx‡Z c‡e‡ki AvM chš †Kvb Ro e¯i wbggLx cZb‡K A_vr e¯i IRb‡K mKj e¯i mnRvZ ag e‡j MY¨ Kiv nZ, hvi †Kvb e¨vL¨vi c‡qvRb †bB| e¯i IRb †h Avm‡j cw_ex I e¯i g‡a¨ AvKl‡Yi ewncKvk GB we‡ePbv wbDUb I Zvi mgmvgwqK‡`i A‡b‡Ki g‡a¨ ùwiZ n‡qwQj| G†`i g‡a¨ ievU ûK wQ‡jb cwm×| †m mgq g‡b Kiv nZ †h cw_exi c‡ôi Dci e¯i MwZ-cKwZ AvKvk gÊ‡j cwiµgYiZ †R¨wZ®‡`i MwZi wbqg †_‡K Avjv`v| wbDU‡bi QvÎve¯vKv‡j AvKvkPvix †R¨wZ®‡`i MwZ, we‡kl K‡i Mn I m‡hi MwZ m¤ú‡K Av‡jvPbv †m mg‡qi GKwU wPËvKlK welq| welqwU 1664 mv‡j †Kw¤R wekwe`¨vj‡qi ÔcvKZ `k‡biÔ (natural philosophy) QvÎ‡`i g‡a¨I Av‡jwPZ nZ| †mKv‡j c`v_ we`¨v‡K ejv nZ cvKZ `kb| 1665 mv‡j gnvgvix AvKv‡i †cM †`Lv w`‡j K‡jR eÜ †NvlYv K‡i QvÎ‡`i hvi hvi ewo‡Z cwV‡q †`qv nq| G‡`i g‡a¨ wQ‡jb ÔK‡j‡Ri eËavix QvÎÔ AvBRvK wbDUb, wZwb ZLb 23 eQ‡ii heK| Djm‡_v‡c Mv‡gi ewo‡ZI Gme ck wbDU‡bi gb‡K Av”Qb ‡i‡LwQj| Mí Av‡Q †h MvQ †_‡K GKwU Av‡c‡ji cZb Zv‡K DÏxß K‡iwQj| Zvi Kv‡Q nVvrB g‡b nj †h ÔgnvKlYÔ e‡j Av‡cjwU cw_exi w`‡K AvKó nq- ‡mB GKB e‡j cw_ex Pv`‡K AvKlY Ki‡Q| wbDU‡bi Kv‡Q cwi®vifv‡e cwZfvZ n‡qwQj †h wbR K¶c‡_ Pv‡`i Ô‡K›`wfM ZiYÔ Avi cw_exi Dci †Kvb e¯i ÔwbgwfgLx Zi‡YÔi Drm m¤eZ GKB| cw_ex c‡ô Roe¯i MwZ Ges gnvKv‡k †R¨wZ‡®i MwZ GKB wbq‡gi Aaxb - GB wPšvaviv mbvZbx HwZn¨ †_‡K ¯Zš| wbDU‡bi mv‡_ m¤úwKZ Av‡c‡ji KwnbxwU KZ`i mZ¨, wbwðZ K‡i ejv hvq bv| Z‡e 1752 Lx÷v‡ã wbDU‡bi eÜ ÷‡Kwj (Stukeley) KËK wjwLZ Zvi Rxeb KwnbxZ †jLK e‡j‡Qb †h GKw`b wZwb wbDU‡bi mv‡_ evMv‡b K‡qKwU Av‡cj Mv‡Qi bx‡P e‡m Pv cvb KiwQ‡jb, †m mgq wbDUb D‡jL K‡iwQ‡jb †h GB GKB ai‡Yi cwi‡e‡k wZwb gnvKl‡Yi cv_wgK avivwU †c‡qwQ‡jb| ÓGwU N‡UwQj GgwbB GK cwi‡e‡k, wZwb e‡mwQ‡jb Mfxi wPšvgM Ae¯vq - Avi ZLbB Av‡cjwU MvQ †_‡K c‡owQj .. .. .. Ó, wj‡L‡Qb ÷‡Kwj| G Mí m¤ú‡K nwKsÔGi gše¨ nj t Ô †h wbDU‡bi gv_vq GKwU Av‡cj covq wZwb AbcwbZ n‡qwQ‡jb - GB cPwjZ KwnbxwU Aek¨B m‡›`ng³ bq| wbDUb wb‡R hv e‡j‡Qb Zv nj, wZwb ÔwPšv Kivi †gRv‡R e‡mwQ‡jbÔ. ÔZLbÔ GKUv Av‡cj co‡Z †`‡L Zvi gv_vq gnvKl m¤ú‡K avivwU G‡mwQj|' (Ref: Stephen Hawking, *A Brief History of Time*, p7, Bantam Books, London, 1995 reprint)

cwiwkó 3| Av‡jvi we”QiY

†Kvb AcwUK¨vj A_vr Av‡jvK †KŠk‡ji (optical device) ‡fZi w`‡q mv`v Av‡jvK, †hgb mhv‡jvK, †ewi‡q G‡j Zv mvZwU isÔGi Dcvs‡k wef³ n‡q c‡o| GB Dcvsk-mß nj t ‡e¸bx (violet)), bxj (indigo), AvKv‡k (blue), meR (green), nj` (yellow), Kgjv (orange), jvj (red)- GKK_vq Ô†ebxAvmnKjvÔ ev Bs‡iRx‡Z (vibgyor)| mvZe‡Yi GB ¸”Q‡K ejv nq eYwjx (spectrum)| mhv‡jv‡Ki mvZ e‡Y wewkóKiY cwµqvi c`v_we`¨vq bvg we”QiY ev dispersion| mhv‡jvK †_‡K eYvjx mwói mnRZg Av‡jvK †fŠZ †KŠkj nj wÎwkiv KvPLÊ hv‡K ejv nq wcRg (prism)| wbDUbB mec_g G cwZfvmwU Ae‡jvKb K‡iwQ‡jb| wbDUb Av‡jv wb‡q Avil bvbv cix¶v-wbix¶v K‡iwQ‡jb, hvi djk“wZ‡Z Av‡jvi e¨wZPvi agl (interference) wZwb cix¶‡Yi gva¨‡g Awe®vi K‡iwQ‡jb| GKwU DËj AZmx KvP Avi mgZj `c‡bi mnvqZvq GKwU mnR cix¶‡Yi gva¨‡g GKeYx nj` i‡Oi e¨wZPvi mwó K‡iwQ‡jb wZwb| GB mij cix¶Y e¨e¯vq chvqµ‡g nj` Av‡jv I AÜKv‡ii PµKvi ejq mwó nq| AÜKvi Avi Av‡jvi GB †Wviv wPÎ‡KB ejv nq e¨wZPvi cvš (interference fringe)| Zvi bv‡g cwiwPZ ÔwbDU‡bi A½ixÔ (Newton’s ring) cix¶YwU MZ AvovBÔk eQi a‡i c`v_ we`¨vi QvÎiv mvZK ‡kYx‡Z AvRI m¤úv`b K‡i Avm‡Q| GiB bvg wK KvjRqx !

wbDUb Av‡jvi cKwZ wb‡qI A‡bK wPšv fvebv K‡iwQ‡jb| cwZdjb, cwZmiY, we”QiY, e¨wZPvi cfwZ Av‡jvi cwZfvm Ae‡jvKb K‡i Zvi aviYv n‡qwQj †h Av‡jv e¯Z GK ai‡Yi KwYKvi mgwó (corpuscles)| KwYKv Z‡Ëi wfwË‡Z wZwb Av‡jvi G‡Zv me wewPÎ cwZfv‡mi c`v_‰ew`¨K e¨vL¨v `v‡bi cqvm †c‡qwQ‡jb| wKš Av‡jvi mij ˆiwLK MwZ Avi Av‡jvi cwZdjb e¨wZ‡i‡K †Kvb NUbviB e¨L¨v wZwb KwYKv Z‡ËÍi wfwË‡Z w`‡Z cv‡ib wb - cix¶‡Y †`Lv hvq Av‡jvi †eM Nb gva¨‡g K‡g hvq, A_P wbDU‡bi KwYKv ZË fwel¨ØvbxK‡i wVK Gi D‡ëwU| †Kej GB AbwgwZwU wm× e‡j MnY Ki‡jB KwYKv Z‡Ëi mnvqZvq Av‡jvi cwZmi‡Yi e¨vL¨v I †m‡ji wbq‡gi cwZôv Kiv hvq| wbDUb aviYv K‡iwQ‡jb †h, Av‡jvK KwYKv¸wj hZB Nb gva¨gwUi c‡ôi w`‡K GwM‡q Av‡m Giv Zxefv‡e AvKó n‡e, Ges d‡j Av‡jvK KwYKvMwj Nb gva¨gwUi †fZ‡i `“ZZi †e‡M awweZ n‡e| Avi gva¨gwU KwYKvmg‡ni MwZ c‡_i w`K cwieZb NUv‡e Awfj‡¤i w`‡K| d‡j MwZc‡_i mv‡_ Awfj‡¤i †KvY (cwZmiY †KvY) nvm cvq| Av‡jvi cwZfvm wb‡q ZwËK M‡elYv I cix¶Y we‡klY wb‡q wbDUb iPbv K‡iwQ‡jb Av‡jvK MšÔAcwUKmÔ (Opticks) 1704 mv‡j| GLv‡b ejv †eva nq Acvmw½K n‡e bv †h Av‡jvi cwZdj‡bi wbqg BDwK‡WiI Rvbv wQj, Avi cwZmi‡Yi wbqg cix¶‡Yi gva¨‡g DBjewW †mj (Wilebrod Snell t 1591-1626) Awe®vi K‡iwQ‡jb| wbDUb e¨_ n‡jI cvPxbZi KwYKv ZË c‡qvM K‡i 1637 mv‡j †i‡b †`Kv‡Z (Rene Descartes t 1596 - 1650) †m‡ji cwZmiY wbqg, hv divmx †`‡k †`Kv‡Zi wbqg bv‡g cwiwPZ, AvniY Ki‡Z mg_ n‡qwQ‡jb| wbDUb G Z_¨ Rvb‡Zb wKbv Rvbv hvq bv|

wbDU‡bi wØZxq weL¨vZ ÔAcwUKmÕ MšwUl AvawbK weÁvb M‡elYvh we‡kl K‡i cix¶Y c`v_we`¨vq cfZ Ae`vb †i‡L‡Q| GwU ZrKv‡j enj Av‡jvPZ cwZdjb I cwZmiY welqK R¨wgwZK Av‡jvK we`¨v msµvš †Kvb HwZwn¨K c¯K bq| e¯Z wbDU‡bi G ai‡Yi Mš iPbvi gj D‡Ïk¨ wQj Av‡jvi cKwZ wb‡q- Av‡jvi cKwZ‡K Awe®v‡ii D‡Ïk¨ wb‡q Av‡jvi bvbv mgm¨v wb‡q m¤úvw`Z bvbv cix¶‡Yi weeiY G‡Z ¯vb †c‡q‡Q| cix¶‡Yi g‡a¨ i‡q‡Qt Av‡jvi we"QiY (dispersion) A_vr mv`v Av‡jv‡K wewfb Dcvs‡k wewkóKiY; Av‡jvi e¨wZPvi (interference) I we‡¶cb (diffraction), wbDUb hvi bvg w`‡qwQ‡jb ÔAšeµZvÕ (inflexion) A_vr Av‡jvi †fZ‡ii w`‡K †e‡K hvIqv| wcwÝwcqv I AcwUK‡mi g‡a¨ Dc¯vcbv c×wZ‡Z i‡q‡Q †gŠwjK cv_K¨| c_gZt wcwÝwcqv †jLv n‡qwQj j¨wU‡b, Avi AcwUKm BsivRx fvlvq| wcwÝwcqvÕi Dc¯vcb c×wZ wQj R¨wgwZK, A_vr c×wZwU M‡o D‡VwQj cwZÁvmgn‡K wfwË K‡i; Gme cwZÁv MvwYwZK cšvq cgwYZ ce cwZÁvmgn, ‡jgv A_ev ¯Ztwm×mgn †_‡K Dr¶wiZ| Ab¨w`‡K AcwUK‡m †iKWKZ wm×všmg‡n wbDUb DcbxZ n‡qwQ‡jb cix¶Y c×wZ‡Z- GLv‡b cwZÁv, mgxKiY ev MvwYwZK A¯ e¨eüZ nq wb| cix¶vjä djvdj we‡klY K‡iB wm×v‡š DcbxZ nIqv †M‡Q| cgvYw` cwZwôZ n‡q‡Q cix¶‡Yi gva¨‡g| GKK_vq wcwÝwcqv hw` ZËxq c`v_we‡`i n‡q _v‡K c_wb‡`kK, Zvn‡j AcwUKm cix¶Y c`v_we‡`i Rb¨ n‡Z cv‡i GKwU D¾j Av‡jvK ewZKv|

AcwUK‡mi Avi GKwU ^ewkó¨ nj, Gi cwiwk‡ó Ašf³ n‡q‡Q †ek wKQ ÓwRÁvmvÓ (queries)| G¸wj g‡a¨ Ašf³ n‡q‡Q cKwZi ^ewPÎgq ccÂ mgvnvi- †hgb D`vniY ¯i¡c Zvckw³i cKwZ I cwiPjb; gva¨vKl‡Yi m¤ve¨ KviY; ivmvqwbK wewµqvi cKwZ; mwói gn‡Z (beginning) Cki †Kvb cwµqvq ÔRoÕ (matter) mwó K‡iwQ‡jb - hvi DËi nwKs mn AvawbK c`v_we`MY L‡R wdi‡Qb; GgbwK gvb‡li ‰bwZK AvPiY ... BZ¨vKvi bvbv ck| GB wRÁvmv¸wj wKš wbQK ck bq, e¯Z Gme ck Z‡j wZwb Gme mgm¨vi DËi †LvRvi †Póv K‡i‡Qb| ck ¸wj DÌvc‡bi ^kjxi ga¨ w`‡qB wZwb wK ei‡Z Pvb Zvi Bw½Z _v‡K| †hgb wbDUb ck K‡ib bv Av‡jv e¯ KwYKv bq wK bv? eis wZwb ckwU‡K Gfv‡e DÌvcb K‡ib, ÔAv‡jv wK e¯ KwYKv bq ?Õ| G †_‡K Avgiv ej‡Z cwi †h, Gai‡Yi c×wZ AbmiY K‡i wbDUb GK ai‡Yi ÔD™vebxgjK cvKwZK `kbÕ (Exploratory natural philosophy) ceZ‡bi †Póv K‡iwQ‡jb - †hLv‡b Áv‡bi gL¨ Drm n‡e cix¶Y I ch‡e¶Y| cix¶Y wfwËK cvKZ `k‡bi GB wbDUbxq HwZn¨ MvwYwZK c×wZ wfwËK cvKZ `kb †_‡K ¯Zš| GB A‡_ AcwUKm MšwU GK ai‡Yi wbDUbxq gZev` (Newtonianism) ceZb Ki‡Z †P‡qwQ‡jb hv Aóv`k kZve`x‡Z ¸i"Z I ghv`vi w`K †_‡K wcwÝwcqvÕi ÔMvwYwZK cvKZ `k‡biÕ (Mathematical natural philosophy) cwZØ›Øx n‡q †`Lv w`‡qwQj|

e¨wZPvi (interference), AceZb (diffraction), mgveZb (polarization) RvZxq Av‡jvi mv‡_ mswkó wKQ wKQ cwZfv‡mi ÔAv‡jvi cKwZ Zi½Õ GB AbKí e¨wZ‡i‡K mPvi" e¨L¨v †`qv hvq bv| GLv‡b D‡jL¨ †h wbDU‡bi R‡b¥i 36 eQi c‡i Ij›`vR c`v_we` Lxwðqvb nB‡Mbm (1629-1695) 1678 mv‡j Av‡jvi Zi½ Z‡Ëi AeZviYv K‡ib| GB ZË aviYv K‡i †h Av‡jv nj GK ai‡Yi Zi½, KwYKvi †mvZaviv bq- hv wbDUb c¯ve K‡iwQ†jb| †mKv†j G `wU ZË wQj ci®úi

we‡ivax I cwZØw»ØZvgjK| nB‡Mbm Av‡jvi Zi½ cKwZ m¤‡Ü wKQ D‡jL K‡ib wb, Zi‡½i gva¨g m¤‡ÜI wQ‡jb m¤úY wbðc| Av‡jv Kx Ab‰`N¨ bv Abc¯ Zi½ cKwZi ‡m m¤ú‡K Zvi †Kvb avivYv wQj bv| Ggb wK `k¨gvb Av‡jvi Zi½ ^`N¨ ev Av‡jvi `“wZ m¤ú‡KI †Kvb Ávb wQj bv| e¯Z g¨v·I‡qj KËK Av‡jvi ÔZwoZ †P Š¤K Zi½Õ Z‡Ëi DÌvc‡bi AvM chš GK kZv㠇i Av‡jvi gva¨g wn‡m‡e nB‡Mbm cieZx c`v_we`iv Kíbv K‡iwQ‡jb Acw_e ÔC_‡iÕi A¯Ë| Z‡e nB‡Mb‡mi mvdj¨ nj, wZwb mv_Kfv‡e Zvi Zi½ ZË w`‡q Av‡jvi mij ^iwLK MwZ, cwZdjb I cwZmiY NUbvi PgKc` e¨vL¨v w`‡qwQ‡jb| ûB‡Mbm Z‡Ëi wfwË wQj R¨wgwZK Mob - hvi mvnv‡h¨ ejv †hZ †h GKwU c`Ë ÔZi½ gLÕ (wave front) fwel¨‡Zi †Kvb GK gn‡Ë †Kv_vq Ae¯vb Ki‡e, eZgvb Ae¯v‡bi mv‡c‡¶| Zvi GB R¨wgwZK Mob bxwZ cieZxKv‡j nB‡Mb‡mi bxwZ (Huygens' principle) bv‡g cwiwPwZ jvf K‡i| d‡Kv (Foucault) 1850 mv‡j mwbwðZfv‡e cix¶‡Yi gva¨‡g cgvY K‡i †`Lvb †h *Av‡jv evZvm A‡c¶v R‡j axi †e‡M P‡j* ; Gi d‡j wbDU‡bi KwYKv Z‡Ëi wfZwU `ej n‡q c‡i Ges Kvjµ‡g c`v_we`‡`i Kv‡Q Gi ¸i“Z wPiZ‡i nwi‡q hvq|

KwYKv Z‡Ëi mnvqZvq e¨wZPvi NUbvi mv_K e¨vL¨ c`vb m¤e bv n‡jI, 1801 mv‡j †_vgvm Bqs cix¶‡Yi gva¨‡g Av‡jvi e¨wZPvi cwZfvm mwó K‡i Av‡jvi Zi½ ZË‡K `pfv‡e cwZwôZ K‡iwQ‡jb| `wU msm³ Av‡jvi Drm †_‡K wbMZ `wU GKeYx Av‡jvK iwk¥ Ggbfv‡e wgwjZ n‡Z cv‡i hv‡Z kw³i (Av‡jvi ZxeZv) ¯wbK eÈb mIg bv n‡q, †Kvb we›`‡Z Av‡jvi ZxeZv m‡eev”P, Avevi Ab¨ we›`‡Z mewbg, Ggb wK kb¨I n‡Z cv‡i| Av‡jvi G ai‡Yi cwZfvm‡K ejv nq e¨wZPvi|

Av‡jv hLb †Kvb AvqZvKvi AwZ ¶` wQ‡`i ‡fZi w`‡q P‡j hvq ZLb Gi cv‡ki KvQKwQ AÂ‡j Av‡jv Zvi mij ^iwLK c_ †Q‡o ‡e‡K hvq; Av‡jvK c‡_i GB †e‡K hvIqv‡KB c`v_we`iv e‡j _v‡Kb Av‡jvi AceZb (diffracrion of light)| AceZb NUbv mec_g Ae‡jvKb K‡iwQ‡jb dvb‡m‡¯‹v gwiqv wMgvjw` (Francesco Maria Grimaldi t 1618-1663) Ges Zv ûB‡Mbm I wbDUb Df‡qiB Rvbv wQj| ûB‡Mbm Zi½ Z‡Ëi ce³v n‡jI wekvm Ki‡Zb bv †h Av‡jvK c‡_ ¯wcZ †Kvb evav AceZb mwó Ki‡Z cv‡i, Avi wbDU‡bi Kv‡Q AceZb NUbv wQj †bnvr Zvrchnxb hv‡K Zi½ Z‡Ëi c‡¶ mv¶¨ wn‡m‡e DÌvcb Kiv †h‡Z cv‡i| G. †R. †d‡bj (A. J. Fresnel : 1788-1827) c_g mv_Kfv‡e nB‡Mb‡mi bxwZ‡K c‡qvM K‡iwQ‡jb AceZ‡bi mPvi“ e¨vL¨vq|

cwiwkó 4| ÔwcwÝwcqvÔi Kwnbx

‡Kw¤‡R wd‡i wbDUb e¯i MwZ-cKwZ wb‡q Zvi cemix M¨vwjwjl l Ab¨vb¨ weÁvbx‡`i a¨vb-aviYv¸wji cYv½ i¡c †`lqvi Kv‡R g‡bwb‡ek K‡iwQ‡jb| GiB djk"wZ‡Z cKwkZ nj 1687 mv‡j wbDU‡bi wekwek"Z KxwZ AvawbK ejweÁv‡bi evB‡ej Ô*Phnlosophiae Naturalis Principia Mathematica*Ô| gvÎ wZbwU wbq‡gi ga¨w`‡q wZwb ejweÁv‡bi wekvj e¨wß‡K †e‡a †d‡jwQ‡jb| M¨vwjwjli Kv‡ji AvM chš Ávbx `vkwbK‡`i aviYv wQj †h †Kvb e¯‡K Pjgvb ivL‡Z n‡j H e¯wUi Dci GK ai‡Yi cfve (influence) ev ej (force) me`v wµqvkxj _vK‡Z n‡e| aviYv Kiv nZ †h e¯wUi Ô¯vfweK Ae¯vÔ (natural state) nj Zvi w¯i Ae¯v (state of rest)| M¨vwjwjlB cix¶‡Yi gva¨‡g G aviYvi cwieZb Kivb, Ges ¸YevPKfv‡e D‡jL K‡iwQ‡jb †h evavM¯ bv n‡j mij †iLvq Pjgvb e¯ Pj‡ZB _vK‡e| M¨vwjwjl Avil e‡jwQ‡jb †h, †Kvb e¯i †e‡Mi cwieZb NUv‡Z ewne‡ji c‡qvRb, †Kvb e¯i mlg MwZ i¶v Ki‡Z †Kvb ej c‡qv‡Mi c‡qvRb nq bv| wbDUb M¨vwjwjli GB c_wei"× aviYvwU‡KB Zvi MwZ wbq‡gi c_g wbq‡g cwZôwbKfv‡e Dc¯vcb K‡iwQ‡jb Zvi wcwÝwcqv M‡š| GB wbqgwU Roc`v‡_i RvX¨ ¸†Yi cKvk ev RoZvi wbqg bv‡g (law of inertia) cwiwPZ| wbDU‡bi mv_KZv nj wZwb ej m¤ú‡K bZb aviYvi Rb¥ †`b, Ges Gi msL¨vevPK msÁv c`vb K‡ib, hv MwY‡Zi fvlvq cKvk Kiv nq **F** = m**a** AvKv‡i| GLv‡b **F** nj m-f‡ii Dci ch³ ej, hv fiwU‡Z **a** cwigvY ZiY mwó K‡i| e¯Zt ej nj e¯L‡Êi m‡½ cwi‡e‡ki wg_w®‹qvi cKvk| D`vniY ¯i¡c Av‡cj-cw_ex wmm‡U‡g, Av‡cjwU hw` Avgv‡`i Av‡jvP¨ e¯LÊ nq, Zvn‡j cw_ex nj Gi cwi‡ek| Dc‡ii mgxKi‡Y Avbcwk K m-a"eKwU‡K ejv nq ÔRvX¨ fiÔ ev RoZvi fi (inertial mass)|

wbDU‡bi wcwÝwcqv ïa weÁv‡bi iv‡R¨ bq, wPšvi Ab¨ †¶‡Îl wecj mvov RwM‡qwQj| A‡bK `vkwbKB wbDU‡bi ¯vb l Kv‡ji AmxgZv l cig ¸‡Yi K_v †g‡b wb‡Z wQ‡jb wØawšZ| wjewbR, evK‡j, GgbwK Avb÷ g¨v‡Ki gZ `vkwbK MwYZÁ‡`i Zxe mgv‡jvPbvi g‡LvgwL n‡qwQ‡jb wZwb| Avevi GK_vI mZ¨ Dwbk kZ‡Ki BD‡ivcxq `k‡bi Dci Mfxi †iLvcvZ K‡iwQj wbD‡Uvbxq c`v_we`¨v| we‡klZ Kv‡›Ui `k‡b †h Gi cfve m®úó G‡Z m‡›`n †bB| wbDU‡bi aviYvq †gKwbKm ïa hšweÁvb A_vr hš evbv‡bvi we`¨v bq, GwU wek Pjrwµqvi gj weavb| wZwb me c_g wek cwiPvjb cwµqvi ˆeÁwbK wfwË c`vb K‡iwQ‡jb MwZ ejwe`¨v l gnvKlxq ZË c¯vebvi ga¨ w`‡q| mZivs wbDU‡bi c¯weZ wbqgvejx e¯Z ÔcKwZi wbqgÔ| wZwb Avgv‡`i GKwU mk•Lj wek Dcnvi †`b hv cKwZi wbq‡g PwjZ nq, mewbqšv †Kvb Ck‡ii n¯ ‡¶c e¨wZ‡i‡KB|* Zvi wPwÎZ wek wZbwU cig mËv (entity) wb‡q MwVZ ¯vb, Kvj l Ro| wbDUb ¯vb m¤ú‡K Dw³ K‡i‡Qb t Ó ... by its very nature remaining the same and immobile without relation to anything external.Ó| Gi A_ n‡jv e¯-MwZ ev ch‡e¶‡Ki MwZi Dci e¯i ^`N¨ ev gvÎv wbfi K‡i bv| Kv‡ji cigZv (absoluteness) m¤ú‡K Zvi gše¨ wQj Ó.... by its very nature flowing uniformly without reference to anything external Ó ¯vb l Kvj ïa

* Z‡e Ckiev`x wbDU‡bi aviYv wQj †h, Cki B‡"Q Ki‡jB we‡ki KgKv‡Ê n¯‡¶c Ki‡Z cv‡ib|

cig mËv bq, wb®‹qô I e‡U, A_vr R‡oi Dcw¯wZ ev Abcw¯wZ, jq ev i¡cvši ‡Kvb wKQB ¯vb ev Kvj‡K ¯úk K‡i bv| wbDU‡bi ejwe`¨vq AšwbwnZ i‡q‡Q G‡K ai‡Yi Av‡cw¶KZvi bxwZ t Ó All systems which move uniformly in a straight line relative to each other are equivalent with respect to all mechanical laws Ó G ai‡Yi cm½ KvVv‡gvmgn‡K ejv nq RvX¨ cm½ KvVv‡gv (inertial frame of reference)| GB bxwZ, hv eZgv‡b wbDUbxq Av‡cw¶KZvi bxwZ bv‡g cwiwPZ, Abmv‡i †Kvb RvX¨ KvVv‡gv‡Z hvwšK cix¶v m¤úv`b K‡i KvVv‡gvwUi mlg MwZ wbaviY Kiv Am¤e| mZivs wbDU‡bi ejwe`¨vi bxwZ Abhvqx cig Ae¯vb ev cig ¯vb‡K aiv hvq bv -- cig ¯v‡bi GB Abw¯Ë wbDUb‡K wePwjZ K‡iwQj wbtm‡›`‡n, KviY Lxó a‡g cig Ck‡ii aviYvi mv‡_ Gi i‡q‡Q Ø›Ø|

wcwÝwcqv MšwU cKv‡ki cðv‡Z i‡q‡Q GKwU HwZnwmK cUfwg| AvVvi gvm a‡i Mv‡gi evmvq ga¨vKl‡Yi mveRbxb ZË I MwYZ wb‡q M‡elYvi djvdj wb‡q †Kb PcPvc e‡mwQ‡jb GwU GK we¯§q wbtm‡›`‡n|* Avgiv wbDU‡bi GKwU Dw³ D×Z Ki‡Z cwi t '*And the same year (1966) I began to think of gravity extending to the orb of the moon …. I deduced that forces which keep the planets in their Orbs must [be] reciprocally as the squars of their distances from their centers about which they revolve: and thereby compare the force requiste to keep the Moon in her Orb with the force of gravity at the surface of the earth and found them answer pretty nearly.*'

1648 mv‡j iq¨vj †mvmvBwU‡Z n¨vwji ag‡KZ L¨vZ ‡R¨wZwe` GWgÛ n¨vwj (Edmund Halley) I ¯cwZ m¨vi Lx‡÷vdvi †i‡bi (Sir Christopher Wren) g‡a¨ MnMwZ m¤ú‡K Av‡jvPbv Kv‡j Zv‡`i g‡b nv"Qj †h †Kcjv‡ii c¯weZ Mnw`i DceËvKvi K¶c_ msµvš ZZxq wbqgwU m¤eZ †R¨wZ®‹ MwZi wbqšY Kvix †Kvb e¨¯eMxq m¤ú‡Ki wfwËi Dci `Êvqgvb| wKš ZLb chš Zv †KD cgvY Ki‡Z cv‡ib wb| Zviv mgm¨wU ievU û‡Ki Kv‡Q DÌvcb Ki‡j ûK `vex K‡iwQ‡jb †h Mn-MwZi cðv‡Z †h e¨¯ZeMxq wbqg we`¨gvb Zv wZwb cgvY Ki‡Z cv‡ib, I GKB mv‡_ ZwËKfv‡e †Kcjv‡ii wZbwU m‡Îi AeZviYv Ki‡eb| †ib †NvlYv K‡ib †h †KD ` gv‡mi g‡a¨ G Kv‡R mdj n‡j Zv‡K 40 wkwjs Dcnvi †`lqv n‡e| wKš ûK ‡Kvb cgvY Dc¯vc‡b e¨_ n‡j n¨vwj ‡Kw¤‡R wM‡q wbDU‡bi Kv‡Q mgm¨wU DÌvcb K‡iwQ‡jb| wbDUb Zvi eÜ‡K wbivm³ wP‡Ë Rwb‡qwQ‡jb †h K‡qK eQi c‡eB wZwb G mgm¨vi mgvavb K‡iwQ‡jb| wKš nv‡Zi Kv‡Q MYbv msµv KvMR cÎ¸wj bv _vKvq n¨vwj‡K †`Lv‡Z cv‡ib wb, Z‡e n¨vwj‡K cwZk"wZ w`‡qwQ‡jb †h wZwb G msµvš cgvYw` c‡i Zvi Kv‡Q cwV‡q †`‡eb| GwUI û‡Ki gZ wfwËnxb `vex g‡b K‡i nZvk n¨vwj e¨_ n‡q jÛ‡b wd‡i Avmvi 3 gvm c‡i j¨wUb fvlvq wjwLZ bq côvi GKwU M‡elYv cÎ wZwb wbDU‡bi KvQ †_‡K †c‡jb, hvi wkibvg wQj Ó *De Motu Corporum* ev *On the Motions of Bodies in Orbit* Ó| evsjvq Avgiv ej‡Z cwi ôK¶c‡_

* A‡bK weÁv‡bi BwZnvm †jLK g‡b K‡ib wZwb m¤eZ evKweZÊv Gov‡Z †P‡qwQ‡jb| g‡b Kiv †h‡Z cv‡i ‡h ô*Theory of Light and Colours* ô wkibv‡g cKwkZ Zvi ceÜwU wbDUb‡K wZ³ ev`vbev‡`i m¤§L †V‡j †`q| `vkwbK evUvÊ iv‡m‡ji g‡Z wbDUb wQ‡jb fxi" I AšgLx ¯fv‡ei| G cm‡½ wZwb e‡jwQ‡jb ôif he had encountered the sort of opposition with which Galileo had to contend, it is probable that he would never have published a line ô| GK_v GLb meRb wew`Z †h eÜ n¨vwji c‡ivPbv‡ZB wbDUb ôwcwÝwcqvô cKv‡k mvnmx n‡qwQ‡jb|

cwiµgYiZ †R¨wZ®‡`i MwZô| GB ce‡Ü wbDUb gnvKl‡Yi e¨¯eMxq wbqg I wZbwU MwZ mÎ c‡qvM K‡i mwVKfv‡e Dcw¯Z Ki‡jb ‡Kcjv‡ii wZbwU wbq‡gi mZ¨Zv| Gfv‡eB wbDUb wcwÝwcqv gnvMš iPbvi c_g avcwU MnY K‡iwQ‡jb| gjZ eÜ GWg‡Ûi cZ¨¶ Pv‡cB 18 gvm cwikg K‡i ôc`v_we`¨vi MwYwZK bxwZgvjvô wkibv‡g wZwb MšwU mgvß K‡iwQ‡jb; ejv evnj¨ †m Kv‡ji HwZn¨ Abhvqx Ávb-weÁvb PPvi evnb j¨wUb fvlvq| wbDU‡bi ¯fve Abhvqx H ¶` wbeÜwU‡K wek`fv‡e we‡klY K‡i 3wU eo AvKv‡ii AvqZ‡bi i¡c w`‡jb| iqvj †mvmvBwUi Znwe‡j A_ bv _vKvq, n¨wji A_e¨‡q ôc`v_we`¨vi MwYwZK bxwZgvjvô ev ms‡¶‡c ôwcwÝwcqvô Ae‡k‡l cKwkZ nj 1687 mv‡ji 5B RjvB| wbDUb eÜi GB mn‡hwMZvi K_v KZÁZvi mv‡_ M‡ši gLe‡Ü Gfv‡e ¯§iY K‡i‡Qb t

In the publication of this work, the most acute and universally learned Mr. Edmund Halley not only assisted me with his pains in correcting the press and taking care of the schemes, but it was to his solicitations that its becoming public is owing; for when he had obtained of me my demonstrations of the figure of the celestial orbits, he continually pressed me to communicate the same to the Royal Society, who afterwards, by their kind encouragement and entreaties engaged me to think of publishing them. But after I had begun to consider the inequalities of the lunar motions, and had entered upon some other things relating to the laws and measures of gravity, and other forces; …. …. I put off that publication till I had made a search into the matters, and could put out the whole together.

wZwb gLe‡Ü R¨wgwZ Avi ‡gKwbK‡mi m¤úK eSv‡Z †gKwbK‡mi fwgKv cm‡½ wj‡L‡Qb,

In this sense rational mechanics will be the science of motions resulting from any forces whatsoever, and of the forces required to produce any motions, accurately proposed and demonstrated. This part of mechanics was cultivated by the ancients in the five powers which relate to manual arts, who considered gravity (it not being a manual power) no otherwise than as it moved weights by those powers. Our design, not respecting arts, but philosophy, and our subject, not manual, but natural powers, we considered chiefly those things which relate to gravity, levity, elastic force, the resistance of fluids, and the like forces, whether attractive or impulsive; and therefore we offer this work as mathematical principles of philosophy; for all the difficulty of philosophy seems to consist in this from the phenomena of motions to investigate the forces of nature, and then from these forces to demonstrate the other phenomena; and to this end the general propositions in the first and second book are directed. In the third book we give an example of this in the explication of the system of the World; for by the propositions mathematically demonstrated in the first book, we there derive from the celestial phenomena the forces of gravity with which bodies tend to the sun and the several planets. Then from these forces, by other propositions which are also mathematical, we deduce the motions of the planets, the comets, the moon, and the sea. I wish we could derive the rest of the phenomena of nature by the same kind of reasoning from mechanical principles; ……. I hope the principles

here laid down will afford some light either to that or some truer method of philosophy.

ÔwcwÝwcqvÕ ev evsjvq Avgiv ej‡Z cwi ÔbxwZgvjvÕ MšwU wZbwU AvqZ‡b wef³, ïi“ n‡q‡Q Pviwu welq wb‡q| msÁv Ab‡”Q‡` fi, MwZ, fi‡eM Ges wZb cKv‡ii ej h_v RvX¨, Av‡iwcZ Ges †K›`wfM m¤ú‡K msw¶ß wKš ¯úó avivYv †`qv n‡q‡Q| cig Kvj, ¯vb, MwZ mgc‡KI GLv‡b wbD‡Ubi avivYvi m‡½ cvV‡Ki cwiPq NwU‡q †`qv n‡q‡Q, Ges Zvi weL¨vZ Óevjwu Zix¶‡YÕi (bucket experiment)Ó mnvqZvq cig ¯vb I MwZi c‡¶ mv¶¨ Dcw¯Z Ki‡Z †P‡q‡Qb| cieZx Ab‡”Q‡` KwZcq ¯Ztwm× (axioms) I MwZ weÁv‡bi Zvi weL¨vZ wZbwU MwZm‡Îi AeZviYv K‡i‡Qb| Gi ci ïi“ nq c¯KwUi 1g LÊ (AvqZb) hvi gj wkibvg n‡”Q Ôe¯Kvqvi MwZÕ (Motion of Bodies); GB As‡k MwZ m‡Îi c‡qvM †`Lvb n‡q‡Q wewfb ai‡Yi K‡¶ Pjgvb e¯Kvqvmg‡ni AvPi‡Yi Dci| 15wU Ab‡”Q‡` m¤úY GB LÊwU| bqwU Ab‡”Q` wb‡q m¤úY 2q L‡Êi Av‡jvP¨ welq nj ce‡n (fluids) A_vr Zij ev evqexq c`v_ RvZxq †ivax gva¨‡g (resistive medium) e¯i MwZ, Ges ce‡ni MwZi AvPiY wb‡q|| 3q L‡Êi gj wkibvg nj wek RMr cxwZ (The System of World), PviwU welq wfwËK wkibv‡g wef³| GLv‡b wbDUb ‡mši RM‡Zi Af¨š‡i Mnw`, Pv`, I ag‡KZ cfwZ †R¨wZ‡®‹i MwZ we‡kl‡Y mveRbxb gnvKl wbqg (law of universal gravitation) c‡qvM K‡i‡Qb| GQviv bvbv cKv‡ii ˆewPÎgq cc‡Âi e¨vL¨v Dcw¯Z K‡i‡Qb, G m‡ei g‡a¨ '‡Rvqvi fvUvÕ (tides), Aqb Pjb (precession of the equinoxes), Ges P›` K‡¶i wbqg-e¨wZµg (irregularities) Ašf³|

wbDUb M‡ši cvi‡¤B c¯‡K e¨eüZ wKQ c` I k‡ãi msÁv w`‡q‡Qb Gi g‡a¨ ¸i“ZcY nj fi (mass) I MwZi cwigvY (momentum)| wZwb wZb †kYxi e‡ji avivYvi mv‡_ Avgv‡`i cwiPq Kwi‡q w`‡q‡Qb| wbDU‡bi fvlvq G me Zvrchgq c`¸wji msÁv nj t

(1) fi t

The quantity of matter is the measure of the same, arising from its density and bulk conjunctly.

(2) fi‡eM ev MwZi cwigvY t

The quantity of motion is the measure of the same, arising from the velocity and quantity of matter.

(3) R‡oi mnRvZ ej t

The vis insita, or innate forces of matter, is a power of resisting, by which every body, as much as in it lies, endeavours to persevere in its present state, whether it be of rest, or of moving uniformly forward in a right line.

(4) ch³ ej t

An impressed force is an action exerted upon a body, in order to charge its state, either of rest, or of moving uniformly forward in a right line.

(5) †K›`wfM ej t

Centripetal force is that by which bodies are drawn or impelled, or any way tend, towards a point as a center.

msÁv m¤úwKZ Ab‡"Q‡`i A‡š¨ wbDUb cig Kvj, cig ¯vb wb‡q bwZ`xN e¨L¨vi AeZviYv K‡i‡Qb| wZwb cig Kvj‡K cKZ Ges MvwYwZK Kvj (true and mathematical time) bv‡g l Awfwnz K‡i‡Qb| cig Kvj m¤ú‡K wbDUb Avgv‡`i aviYv w`‡q‡Qb †h †Kvb ewnc¡i‡e‡ki cm‡½i ‡Zvqv°v QvovB GKw`‡K e‡q Pj‡Q| Kv‡ji Avi GK bvg Aek¨ ¯wqZ (duration), hv †Kvb Ro e¯i MwZ w`‡q cwigvc Kiv nq, †hgb cw_exi AwýK MwZ; Gi ¯wqZ‡K ejv nq Ôw`emÕ| Kv‡ji GB cwigvc‡K wbDUb e‡j‡Qb Av‡cw¶K, AvcvZ ev mvaviY mgq (relative, apparent, common time)| wbDU‡bi aviYvq Ôcig ¯vbÕ meKv‡jB m`k Ges ¯vb (similar and immovable), Avi ¯v‡bi GB ag †Kvb ewnKvV‡gvi Dci wbfi K‡i bv| Avi Av‡cw¶K ¯vb nj †Kvb Pjgvb gvÎv (movable dimension) A_vr cig ¯v‡bi cwigvc, hv Avgv‡`i B›`q wbYq Ki‡Z cv‡i e¯Kvqvmg‡ni Ae¯v‡bi †cw¶‡Z| ‡hgb, cw_exi mv‡c‡¶ fMf¯, AvKvk¯, ev †R¨wZMMb¯ (celestial) †Kvb ¯v‡bi Ae¯v‡bi cwi‡cv¶‡Z cwigwcZ gvÎv| wbDUb †cm I †¯ú‡mi (place and space) g‡a¨ cv_K¨ K‡i‡Qb- †cm nj wbDU‡bi fvlvq Ô a part of space which a body takes up, and according to the space, either absolute or relative Õ ; †cm I †¯ú‡mi Avgiv evsjv Ki‡Z cwi ÔAwaKZ AÂjÕ I ¯vb| G cm‡½ wbDUb Avi l e‡j‡Qb Ggb n‡Z cv‡i †h Ggb †Kvb e¯Kvqvi nq‡Zv †Kvb A¯ËB †bB †hwU cKZB w¯i, hvi mv‡c‡¶ Ab¨ †Kvb e¯Kvqvi ÔAwaKZ AÂjÕ Ges MwZi K_v D‡jL Kiv hvq| Ôcig w¯iÕ Avi ÔAv‡cw¶K w¯iÕ Ges cig I Av‡cw¶K MwZi g‡a¨ cv_K¨ wKfv‡e Kiv hvq G wb‡q wbDU‡bi e³e¨ n‡"Q ÔG‡K A‡b¨iÕ g‡a¨ cv_K¨ Kiv hvq G‡`i agvejx hvPvB I Kvh-Kvi‡Yi mÎ a‡i| w¯iZvi ag nj cKZ mKj w¯i e¯KvqvB ci¯ú‡ii mv‡c‡¶ w¯i _v‡K| wbDUb G cm½wU Zvi e¨L¨vgjK (scholium) Ab‡"Q‡` Gfv‡e G‡b‡Qb - ÔAnd therefore as it is possible, that in the remote regions of the fixed stars, or perhaps far beyond them, there may be some body absolutely at rest; but impossible to know, from the position of bodies to one another in our regions whether any of these do keep the same position to that remote body; it follows that absolute rest cannot be determined from the position of bodies in our regions.Õ wZwb µgvš‡q MwZi ag, KviY I djvdj wb‡q Zvrchgq Av‡jvPbv K‡i‡Qb hv Zvi `vkwbK mjf fvebvi cKvk|

hw` I Zvi †fŠZ ZËw` mÎvq‡b wbDUb‡K K¨vjKjvm Awe®vi Ki‡Z n‡qwQj, wKš wcwÝwcqvÔi mgm¨v wePv‡i K¨vjKjv‡mi fvlv e¨envi bv K‡i BDwKwWq R¨vwgwZK c×wZ e¨envi, A_vr ¯Zwm×, cwZÁv, Abwm×vš Ges wewea †jgvi AeZviYv K‡i‡Qb| wcwÝwcqv‡Z wbDUb Zvi †mB weL¨vZ ÔHypotheses non fingo (I feign (to assert as if true) no hypotheses)Õ Dw³wU cKvk K‡iwQ‡jb| cvmw½K Ab‡"Q`wU nj t

I have not as yet been able to discover the reason for these properties of gravity from phenomena, and I do not feign hypotheses. For whatever is not deduced from the phenomena must be called a hypothesis; and hypotheses, whether metaphysical or physical based on occult qualities or mechanical, have no place in

experimental philosophy. In this philosophy particular propositions are inferred from the phenomena, and afterwards rendered general by induction.

eû cwÊZR‡bi g‡Z weÁv‡bi Ici hZ wecevZ¥K Mš cKwkZ n‡q‡Q m¨vi AvBRvK wbDU‡bi ÔwcwÝwcqvÕi gZ †Kvb MšB wPšv I Áv‡bi RM‡Z GZUv cfve we¯vi K‡i wb| Av_vi †ewi Zvi 'History of Astronomy' M‡š D‡jL K‡i‡Qb †h mgM †R¨wZwe`¨vi BwZnv‡m †Kvcwbkv‡mi 'De revolutionibus' Gi mv‡_ U‡jgxi 'Almagest' I wbDU‡bi 'Principia'i Zjbv n‡Z cv‡i| GB weivU cwZfvi AwaKvix Bs‡iR MwYZÁ I c`v_we` Rb¥ MnY K‡iwQ‡jb 1642 mv‡j Djm‡_vc (Woolsthrope) Mv‡g Avi gZ¨ eiY K‡ib 1727 mv‡j 85 eQi eq‡m| `xNKvj †Kw¤‡R Aa¨vc‡Ki c` AjsKZ K‡iwQ‡jb, wekwe`¨vj‡qi cwZwbwa wn‡m‡e cvjv‡g‡›Ui m`m¨, Ges cwPk eQi a‡i wQ‡jb iqvj †mvmvBwUi mfvcwZ| ÔwcwÝwcqvÕi Bs‡iRx Abev` c_g cKwkZ nq 1729 mv‡j, Abev` K‡iwQ‡jb GÊ †gv‡Ë (Andrew Motte)|
Zvi GB we¯§qKi cwZfvi K_v ¯§i‡Y †i‡LB Av‡jKRvÛvi †cvc (Alexander Pope) Zvi †mB weL¨vZ Dw³wU K‡i‡Q‡jb t

Nature and Nature's laws
Lay hid in night,
God said, "Let Newton be !"
And there was light.

wbDU‡bi Ab¨vb¨ K‡qKwU Mš t wbDU‡bi RxeÏkvq Avi I K‡qKwU Mš cKwkZ n‡qwQj. Gi g‡a¨ i‡q‡Q-

1. wbDU‡bi A¨vbwjwmwm (*Analysis*), j¨wUb fvlvq 1711 Lxóv‡ã cKwkZ| eBwUi c‡iv bvg Ô*ANALYSIS Per Quantitatum SERIES FLUXIONES, AC DIFFERENTIAS* Õ, hw` I Õ *Analysis* Õ bv‡g mvavi‡Y¨ cwiwPZ| G†Z ¯vb †c‡q‡Q wbDU‡bi hveZxq MwYwZK Kg| Avek¨ Gi wKQ wKQ Ask wcwÝwcqv I AcwUKmÔG cKwkZ n‡q‡Q| MšwU‡Z i‡q‡Q t PviwU MwYwZK we‡klY-ceÜ (Mathematical Treatise) Ges K¨vjKjv‡mi Dci KvR m¤úwKZ wKQ bgbv wPwVcÎ, hv K¨vjKjvm D™ve‡bi AMMwgZv wb‡q weL¨vZ wbDUb-wjewbR (Leibniz) weZ‡Ki Dci wKQUv Av‡jvK cvZ K‡i| GB PviwU wbe‡Üi g‡a¨ `wU (*Tractatus de quandrata curvarum* Ges *Enumeratione linearum tertilordinis*) AcwUKvi c_g ms®‹i‡Y cKwkZ nq (1704)| ZZxq wbeÜwUi (hv c‡e cKwkZ nq wb), wkibvg wQj Õ *De methods differentialis* Õ Gi g‡a¨ i‡q‡Q 1676 mv‡ji w`‡K m¤úvw`Z Ggb me Kv‡Ri weeiY hv eZgv‡b wbDUb-‡e‡mj ev wbDUb-÷wjs mÎvw` (*Newton-Bessel or Newton-Stirling formulas*) bv‡g cwiwPZ|

MšwUi gnviZ Aek¨ PZ_Zg wbeÜwU, hv e¯Z GKwU ¶` cw¯Kv ¯i¡c| Gi wkibvg - Õ *De Analyst Per Aequationes Numero Terminorum Infinitas* Õ, wjwLZ n‡qwQj 1669 mv‡j, wKš cKwkZ nq wb| c¯KvKv‡i Õ`¨ A¨vbwj÷Õ †jLvi Ab¨Zg KviY wQj K¨vjKjv‡mi D™ve‡bi ce KwZZ cwZôv| iwPZ nlqvi c‡i cw¯KwU‡K wZwb BsivR MwYZwe` AvBRvK ev‡iv‡K w`‡qwQ‡jb,

whwb Rb Kwjbm mn Ab¨vb¨ cL¨vZ MwYZÁ‡`i †`wL‡qwQ‡jb| Gi d‡j `¨ A¨vbwj÷ n‡q DVj wbDU‡bi K¨vjKjvm m¤úwKZ Kv‡Ri ixwZe× Av‡jvPbv, hv mavi‡Yi gv‡SI cPwiZ n‡qwQj| GwU‡K AaawbK MwY‡Zi BwZnv‡m GKwU `wjj wn‡m‡e we‡ePbv Kiv †h‡Z cv‡i|

2. wbDU‡bi bv‡g Avi GKwU Mš cKwkZ n‡qwQj 1707 mv‡j, Gi wkibvg nj- Å**Arithmetica Universalis**Å| eBwU Avm‡j wbDUb †h me eËZv wekwe`¨vjq jvB‡eix‡Z Rgv w`‡qwQ‡jb Zvi wfwË‡Z ^Zix K‡i jKvwmqvb Aa¨vcK wn‡m‡e wbDU‡bi DËimix DBwjqvg ûBUmb cKvk K‡iwQ‡jb| wKš wbDUb G ms®‹iYwU cQ›` K‡ib wb, - ZvB nq‡Zv MšKvi wn‡m‡e Zvi bvg Qvcv‡Z w`‡Z A¯xKvi K‡ib, d‡j MšKv‡ii bvg QvovB c¯KwU cKwkZ nq| 1720 mv‡ji Bs‡iRx ms®‹i‡Y wKsev 1722 mv‡j j¨vwUb fvlvi wØZxq ms®‹i‡YI †jLK wn‡m‡e wbDU‡bi bvg Qvcvb nq wb|

3. wbDU‡bi bv‡g G chš Awe®KZ 60wU cvÊwjwci mÜvb cvlqv †M‡Q, hvi g‡a¨ i‡q‡Q MYbv, wcwVcÎvw`, A¨vj‡Kwg I agZË m¤úwKZ bvbv wPšvfvebv (musing) | G¸wj †_‡K wbDU‡bi wewfbagx GKv‡WwgK KgZrciZvi cwiPq cvlqv hvq| Gi g‡a¨ mePvB‡Z PgKc` cvÊwjwcwU n‡"Q- cwiKíbv, PvU, Ges ¯vc‡Z¨i weeiY BZ¨vw` wb‡q QqwU †¯‹P mn 84 côvi m‡jvgb gw›`‡ii AvKwZ wb‡q| Gi wkibvg n‡"Q t Å A treatise on or Remarks on Solomon's TempleÅ| GLv‡b D‡jL¨ †h Aóv`k kZ‡Ki ï i"‡Z agËxq AbmwÜrmvq m‡jvgb gw›`‡ii AvKwZ wQj GKwU cwm× c‡nwjKv|

cwiwkó 5| †Kcjv‡ii Kwnbx

†Ivok - mß`k kZ‡Ki wZb w`Kcvj †R¨wZwe‡`i Ab¨Zg n‡jb †Rvnv‡bm †Kcjvi (1571-1630); Ab¨ `Rb UvB‡Kv ev‡n (1546-1601) I M¨vwjwjI M¨vwjwj (1564-1642)| G‡`i g‡a¨ e‡qv‡R¨ô UvB‡Kv ev‡n wQ‡jb wbLZ cix¶Y †R¨wZwe`, Avi Zvi mgq †_‡KB AvawbK ch‡e¶Y wfwËK †R¨wZwe`¨vi mPbv| wbfj †R¨wZIxq ch‡e¶‡Yi gva¨‡g wZwb †h wecj A_P mk•Lj Z_¨fvÊvi M‡o Z‡jwQ‡jb †R¨wZweÁv‡b Zvi gj¨ Acwimxg| gZev‡`i w`K †_‡K Aek¨ wZwb wQ‡jb U‡jgx cšx, A_vr f‡K»`K gZev‡`i mg_K| †Wbgv‡Ki AšMZ j¨vÊ‡M‡fi ivRvi A_vbK‡j¨ †Kv‡c†n‡M‡bi Kv‡Q û‡qb Øx‡ci GKwU ceZ-wkL‡i UvB‡Kv ev‡n GKwU wekvj gvbgw»`i M‡o †Zv‡jb, †hLv‡b 1576-1597 mvj chš wZwb †R¨wZweÁv‡bi cix¶Y mvabvq wbgM wQ‡jb| gvbgw»`iwUi bvgKiY Kiv n‡qwQj Ô¯‡Mi gw»`iÕ (qiwY‡evM)| wKš ivRvbMn ‡_‡K ewÂZ n‡j, Zv‡K gvbgw»`i, GgbwK ‡`k Z¨vM K‡i cv‡M Avkq wb‡Z nq| Rvgvb mgvU 2q i“Wj‡di e`vb¨Zvq ev‡n cbivq be D`¨‡g cv‡M Avi GKwU PgrKvi gvbgw»`i ¯vcb K‡ib (1598)| 1600 mv‡j †Kcjvi UvB‡Kv ev‡ni M‡elYv mnKvix wbh³ nb, Ges UvB‡Kvi gZ¨i (1601) ci be cwZwôZ gvbgw»`‡ii Aa¨¶ c` jvf K‡ib|

1600 mv‡j UvB‡Kvi gvbgw»`‡i mnKvix wn‡m‡e †hvM`v‡bi c‡eB ‡R¨wZweÁvbx wn‡m‡e †Kcjv‡ii L¨wZ mviv BD‡iv‡c Qwo‡q c‡o| cv‡qwMK c×wZ AbmiY K‡i wZwb Mn‡`i cvi¯úwiK `i‡Zi g‡a¨ R¨wgwZK m¤úK wb‡q Zvi `xNKv‡ji M‡elYvi dmj MšvKv‡i 1596 mv‡j cKvk K‡ib| `xN wkibvg h³ Ó*Prodromus dissertationum cosmographicarum continens mysterim cosmographicum*Ó ev ms‡¶‡c *Mysterium cosmographicum* MšwUi cwZwjwc wZwb M¨vwjwjI I UvB‡Kv ev‡n mn A‡b‡Ki wbKU cwV‡qwQ‡jb| ev‡n GB Zi“Y †R¨wZwe‡`i †gavq g» n‡q, †Kcjvi †h †KvcwbKvm cšx †R‡bI, Zvi gvbgw»`‡i KvR Kivi AvnŸvb Rvbvb| ev‡n Zv‡K g½j M‡ni MwZ mgm¨v wb‡q KvR Kivi `wqZ Acb K‡iwQ‡jb| Avi MšwU †c‡q M¨vwjwjI †Kcjvi‡K wj‡LwQ‡jb, ÓAv‡`¨vcvš Avcbvi MšwU Awg coe Ges Avgvi `p wekvm Gi †ek wKQ Ask Avgv‡K g» Ki‡e| G KvRwU Awg Avi Avb‡›`i mv‡_ Kie G Kvi‡Y †h eû w`b hver Awg wb‡R †KvcwbKv‡mi cwiKíbvq Av¯vkxj| Awg j¶¨ K‡iwQ †q GB cwiKíbvq eû cvKwZK NUbvi mnR e¨vL¨v cvIqv hvq, hv mavivYZ cPwjZ cwiKíbvq †ek `‡eva¨| †k‡Iv³ cwiKíbvi Am½wZ I Î“wU cgv‡Yi D‡Ï‡k¨ Awg eû hw³ msMn K‡i †i‡LwQ, wKš Zv cKv‡k Awg mvnm cw”Q bv| Avcbvi gZ Avi A‡bK e¨w³ _vK‡j Avgvi wPšvaviv cKvk Ki‡Z wbðq Awg mvnm †cZvg| wKš Zv nevi bq, ZvB G ai‡Yi c‡Póv †_‡K eZgv‡b weiZ AwQ|Ó

1604 Lx÷v‡ã GKwU bZb b¶‡Îi Awefve wb‡q wZwb `wU M‡elYv ceÜ iPbv K‡ib, Ges Gi wKQw`b ciB evqgÊ‡j Av‡jv‡Ki cwZmi‡Yi Kvi‡Y †R¨wZ®‡`i AvcvZ †h cwieZb `ó nq Zv wb‡q wek` Av‡jvPbvgjK Ô*Ad Vitellionem paralipomena quibus astronomiae pars optica traditur* bv‡g Zvi weL¨vZ MšwU cKwkZ nq| c¯KwU‡Z †R¨wZwe`¨vi ch‡e¶†Yvc‡hvMx

`iex¶Y hš wbgvY-‡KŠk‡ji wek` weeiY i‡q‡Q| g½j Mn m¤úwKZ M‡elYv I M‡elYv j× mvavi Y djvdj wb‡q †Kcjv‡ii me‡kô KxwZ ÔAstronomianova … physica coelestis, tradita commentaritis de motibus stellae Martis Õ ev ms‡¶‡c *Commentaritis de motibus stellae Martis* wkibv‡g †gŠwjK MšwU 1609 mv‡j cKvwkZ nq| ejv evûj¨ †h D³ MšwU mgM †R¨wZwe`¨v m¤úwKZ M‡elYv mwn‡Z¨i GKwU AZ¨¾j iZ| †Kcjv‡ii wZbwU weL¨vZ m‡Îi `wUB GLv‡b ¯vb †c‡q‡Q| Avi ZZxq mÎ m¤wjZ MšwUi wkibvg wQj ÔHaemonices mundiÕ, hv 1619 mv‡j cKvwkZ nq, ZLb B‡Zvg‡a¨B †Kcjvi ivR‰bwZK Kvi‡Y cvM Z¨vM K‡i DËi A÷qvq wjbr†Ri GK AL¨vZ we`¨vj‡q MwY‡Zi Aa¨vcK wn‡m‡e KgiZ| wjbr†R†Z Ae¯vb Kv‡jB wZwb Zvi mePvB‡Z weZKgjK MšwU Ô*Epitome astronomiae Copernicanae* Õ cKvk (1618-21) K‡i f‡K›`ev`x I agev`x‡`i †Pv‡L wewØó n‡q c‡ob| MšwU ‡Kvcwbkv‡mi †mŠi RvMwZK g‡Wj†K mg_b I Avi l DbZZi chv‡q Avbq‡bi Kvi‡Y f¨vwUKvb PvP KËK wbwl× MšZwjKvq Ašf³ nq| BwZg‡a¨ (1616) †Kvcwbkv‡mi *De revolutionibus* MšwU PvP KËK wbwl× †NvwlZ n‡q‡Q|

‡Kcjv‡ii MnMwZ msµvš wZbwU weL¨vZ mÎ, hv †mŠi †K›`K gZev`‡K m‡›`nvZxZfv‡e cix¶‡Yi `p wfwËi Dci `vo Kwi‡qwQj, wKš UB‡Kv ev‡ni †R¨wZlxq m² ch‡e¶‡Yi dmj| BwZn‡mi wK wbgg cwinvm †h UvB‡Kv ev‡ni Rxebe¨vcx mvabv wQj cix¶‡Yi I ch‡e¶‡Yi ga¨ w`‡qB wZwb U‡jgxi f‡K›`K gZev`‡K wPiKv‡ji Rb¨ cwZôv Ki‡eb| Avi G Kv‡R wb‡qvM K‡iwQ‡jb ‡Rvnv‡bm †Kcjvi‡K (Johannes Kepler)| wKš †Kcjv‡ii MwYZ-cwZfv I DcvË we‡klbx ¶gZv cwZôv Kij wVK wecixZ cwZÁv‡K A_vr †Kvcwbkv‡mi †mŠi‡K›`K gZev`‡K| cvV‡Ki †KŠZnj wbevi‡Y †Kcjv‡ii Mn MwZ msµvš wZbwU wbqg GLv‡b weaZ nj t

1| mh‡K GKwU †dvKvm we›`‡Z †i‡L MnmKj DceË c‡_ cwiµgY K‡i (K¶c‡_i wbqg)|
(*All planets move in elliptical orbits having the sun as one of the focus*)

2| GKB Kvj-e¨eav‡b M‡ni †h ‡Kvb Ae¯v‡b mh †_‡K Mn chš ms‡hvRx mij †iLv GKB cwigvY †¶Îdj iPbv K‡i _v‡K (†¶Îd‡ji wbqg); A_vr M‡ni †¶ÎvqZwbK †eM mgvb|
(*A line joining any planet to the sun sweeps out equal areas in equal times*)

3| MnmK‡ji m‡hi PZw`‡K AveZb Kvj ev fMb-Kv‡ji (period of revolution) eM mh †_‡K Zv‡`i ga¨K `i‡Zi Nbi Avbcw ZK (AveZb Kv‡ji wbqg)|
(*The square of the period of any planet about the sun is proportional to the cube of the planet's mean distance from the sun*)

cm½Z D‡jL¨ †h Mn‡`i cvi¯úwiK `i‡Zi g‡a¨ †h GK Aw¼K AbcvZ we`¨gvb GB wekvm †Kcjvi‡K mviv Rxeb Zvov K‡i †ewo‡q‡Q| R¨wgwZK c×wZ‡Z G AbcvZ wbY‡qi Zvi c_g †Póv wed‡j †M‡jl Zvi Avkv wQj †h Ab¨ †Kvb cšvq G m¤úK wZwb cwZôv Ki‡eb; Avi GiB djk"wZ nj ev‡ni msMnxZ †R¨wZlxq Z_¨ I DcvË we‡kl‡Yi wfwË‡Z *Haemonices mundi* MšwUi iPbv I cKvkÑ †hLv‡b fMb Kvj m¤úwKZ mÎwUi wjwce× Kiv n‡q‡Q| MwY‡Zi fvlvq mÎwU wbgfv‡e cKvk Kiv hvq t

$T^2 \propto r^3$; A_vr $\frac{T^2}{r^3} = C$;
GLv‡b, T = M‡ni fMb Kvj,
r = mh †_‡K M‡ni Mo `iZ, Ges C nj Avbcw‡ZK a"eK|

mh †_‡K cw_exi `iZ‡K hw` 1 GKK aiv nq, Ges GB GK‡K Ab¨ Mnw`i `iZ cKvk Kiv hvq, Ges cw_exi fMb Kvj‡K 1 GKK a‡i Ab¨ Mn mK‡ji fMb Kvj cKvk Kiv hvq Zvn‡j cw_exi Rb¨ (T^2 / r^3) Abcv‡ZwUi A_vr C Gi gvb n‡e 1| †Kcjvi †`wL‡q‡Qb †h ea †_‡K kwb chš mKj M‡ni Rb¨B GB Abcv‡Zi gvb GK| D`vniY ¯i¡c cw_exi fMb Kv‡ji Zjbvq g½‡ji Kvj nj 1.88 Avi mh ‡_‡K Mo `iZ 1.524| Zvn‡j g½‡ji Rb¨ Abcv‡ZwUi gvb `vov‡"Q $\frac{T^2}{r^3} = C = (1.88)^2 / (1.524)^3 = 3.54/3.54 = 1$|

wfb cšx n‡jI UvB‡Kv ev‡ni cwZ Zvi wQj Amxg k×v‡eva| HwZwn¨K c×wZi wfwË‡Z †Kcjv‡ii cv_wgK MYbvi wnmve Abhvqx R¨vwgwZK wnmv‡ei Mowgj gvZ AvUwgwb‡Ui cv_‡K¨ G‡m `vovq (g½‡ji Rb¨)| mvaviY †R¨vwZweÁvbx n‡j †h †KD G‡ZB mšó _vK‡Zb GB e‡j †h G cv_K¨ ch‡e¶Y Î"wU RwbZ| wKš c_gZ †Kcjv‡ii HwZwn¨K U‡jgxq cwiKíbvq Av¯v wQj bv, Avi wØZxqZ ev‡ni m² ch‡e¶‡Yi cwZ wQj Acwimxg Avšv| wZwb wekvm K‡iwQ‡jb †h c`wkZ 8 wgwb‡Ui cv_K¨ ch‡e¶Y RwbZ bq, ZËMZ| G cm‡½ †Kcjvi *Commentaritis de motibus stellae Martis* M‡š wj‡L‡Qb t

> Ck‡ii Ki"Yvq Avgiv UvB‡Kvi gZ GKRb AwZ mveavbx ch‡e¶K †c‡qwQ; GB wnmv‡e Zvi ch‡e¶Y †_‡K 8 wgwb‡Ui Miwgj †`Lv hvq ... | KZÁZvi mv‡_ GB `vb ¯xKvi I Zvi mØ¨envi Kiv Avgv‡`i Rb¨ mgxPxb n‡e, ... KviY 8 wgwbU †`kvš‡ii Miwgj Z"Q g‡b Ki‡j †lvok cwi‡"Q‡` Awg †h cwiKíbvi K_v D‡jL K‡iwQ Zv h‡_ó wb‡`vl| wKš GB cv_K¨ Z"Q Kivi gZ bq; GB 8 wgwb‡Ui MiwgjB †R¨vwZwe`¨vi m¤úY ms¯v‡ii c_ cwi®vi K‡i w`‡q‡Q Ges GwUB Avgvi M‡ši cavb Av‡jvP¨ welq|

m¤eZ †Kcjv‡ii †kl iwPZ Mš ÔTabulae Rudolphinae Õ, hv 1627 mv‡j cKwkZ nq| GwU Mn m¤úwKZ Zvi weL¨vZ I wek` †R¨vwZlxq ZwjKv hv wZwb `xN 25 eQi a‡i cYqb K‡ib| GwU cKv†ki ci cieZx GKk eQ‡ii g‡a¨ Gi †P‡q DbZZi †R¨vwZlxq ZwjKv Avi cYxZ nq wb| GB gnvgj¨evb MšwU wZwb Zvi cô‡cvlK I ¸YMvnx mgvU i"Wj‡di D‡Ï‡k¨ DrmM K‡iwQ‡jb| Gi GK eQi Av‡M (1626) Zv‡K wjbr†R †Q‡i Dj‡g‡Z Avkq wb‡Z nq, KviY †mLv‡b ïi" nq †cv‡U÷v›Ut`i Dci Drcxob| †kl eQi wZbwU †Kcjv‡ii Kv‡U `tmn Ae¯vi ga¨ w`‡q GK ¯vb †_‡K Av‡iK¯v‡b D‡Ïk¨nxbfv‡e N‡i| Ae‡k‡l GK ivR‡mbvcwZ f¨v‡jbUvB‡bi †m$R‡b¨ wZwb †c‡jb ió‡K †R¨vwZwe`¨vi Aa¨vcK c`| wKš G †m$fvM¨ wUKj bv, cZb NUj Zvi cô‡cvl‡Ki cZb| Zvi †eZbI evKx coj, hv Av`v‡qi Rb¨ wZwb hvÎv K‡iwQ‡jb i¨vwUme‡bi D‡Ï‡k¨

ÔWv‡q‡UiÕ wbKU Av‡e`b Rvbv‡Z| wKš †mLv‡b †cŠQevi K‡qKw`b c‡iB c_k‡g Kvš Aemb I fM¯v‡¯¨ wZwb †kl wbkvm Z¨vM K‡ib 15B b‡f¤i, 1630 mvj| bMi †Zvi‡Yi evB‡i Zv‡K mgwnZ Kiv n‡j I, AvR Avi G mgwai †Kvb wPý †bB|

agms¯v KËK †Kvb kvw¯ bv †c‡j I GB gnvgbxlx‡K me mgqB h× Ki‡Z n‡q‡Q GB agvÜ‡`i wei“‡×| wZwb evi evi M¨wjwjl‡K DØ× Kivi †Póv K‡i‡Qb †mŠi‡Kw›`K gZev‡`i c‡¶ Zvi hw³-cgvY mK‡ji mvg‡b cKv‡ki Rb¨| wKš ¯‡`kxq e“‡bvi fvM¨ †`‡L M¨wjwjl mvnm mÂq Ki‡Z cv‡ib wb| wKš Zv‡ZI †kl i¶v nq wb|