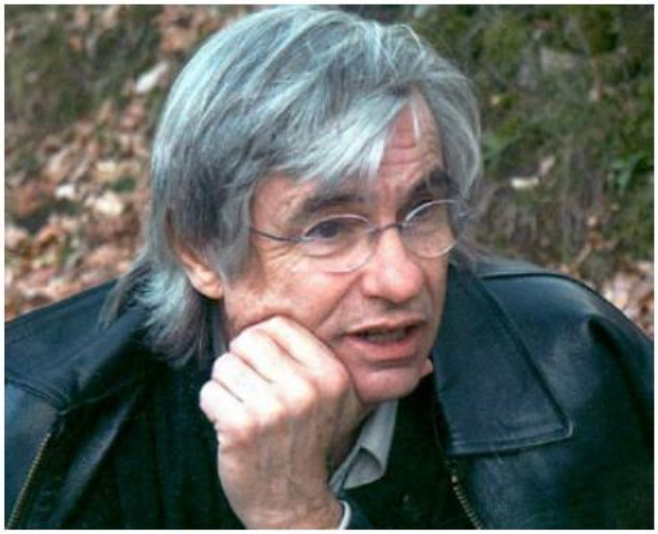
Ubumenyi butagira Imipaka

Itegeko ryo mu 1901 rigenga amashyirahamwe



Jean-Pierre Petit, Perezida w'iri Shirahamwe

Uyu Jean-Pierre Petit, Peresida w'iri shyirahamwe ry'**Ubumenyi butagira Imipaka**, yahoze ari diregiteri w'ubushakashatsi mu kigo cy'inzobere cya CNRS, mu Bufaransa. Akaba kandi inzobere ihanitse muri Fizike y'inyenyeri (Asitorofizike); yahimbye uburyo bushyashya by'inyandiko bita: *Ibitabo by'amashusho by'ubumenyi.* "**Ubumenyi butagira Imipaka**" ni ishyirahamwe ryahimbwe mu 2005 n'abagabo babiri, Jean-Pierre Petit na mugenzi we Gilles d'Agostini. Iri shyirahamwe ryihaye intego yo gukwirakwiza kw'isi hose ubumenyi ku buntu harimwo n'ubumenyi bwa tekinike, ubukorikori n'ikoranabuhanga. Iri shyirahamwe ribeshejweho n'inkunga rihabwa. Izo nkunga nizo ziriha abantu bahindura inyandiko mu zindi ndimi. Buri nyandiko (igitabo cy'amashusho cy'ubumenyi) ihindurirwa mu rundi rurimi ku mafaranga angana n'amayero 150 (150 euros) kuva mu 2007 kugeza ubu. Iri shyirahamwe rinariha amafaranga ajyanye n'iyoherezwa ucishije muri banke ry'ayo mafaranga y'ihinduranya mu zindi ndimi. Abahinduranyi b'indimi bagiye bongera, buri munsi, umubare w'ibyo bitabo bisomwa hose k'ubuntu. (Nko kugeza mu 2007, hari hamaze kuboneka ibitabo magana abiri (200) bikurwa kuri interineti k'ubuntu kandi byanditse mu ndimi makumyabiri n'umunani (28) harimwo ikinyarwanda n'ururimi rwo muri Lawosi).

Biremewe ko iki gitabo gikopororwa cyangwa gifotorwa,cyose cyangwa igice; kinakoreshwa n'abarimu mu masomo ariko mu buryo butari ububyara inyungu z'amafaranga. Gishobora gushyirwa mu masomero y'uturere, y'amashuri cyangwa ya za kaminuza, cyanditse ku mpapuro cyangwa cya shyizwe mu miyoboro y'imbuga z'ikoranabuhanga zigose (intranet).

Uyu mwanditsi w'ibi bitabo yatangiye kwandika ibindi byo byoroshye kandi bigenewe abana bato (bari mu rugero rw'imyaka 12). Ibindi biriho bikorwa n'ibitabo by'amajwi avuga, bigenewe abatazi gusoma cyangwa abashaka kwiga urundi rurimi rutari urwo bakuriyemwo.

Iri shyirahamwe rishaka buri gihe abahinduranyi b'inyandiko bazishyira mu ndimi zabo zakavukire ariko bafite ubuhanga buhagije bwo gutanga inyandiko mpiduranyi nziza z'ibitabo basomye.

Ushatse kugira icyo ubaza cyangwa ugeza kuri iri shyirahamwe, wajya ku rubuga rwaryo ku interinete aha hakurikira: http://www.savoir-sans-frontieres.com

Iranga-konti mu Bufaransa → Inyandiko ngaragaza mutungo muri (RIB)

Ikigo	Umwanya wo kwakiriramwo amafaranga	Nimero ya konti	Urufunguzo rwa RIB
20041	01008	1822226V029	88

Aho ikorera: Banki ya Posita
Hagati y'Umujyi wa Marseille
13900 Marseille CEDEX 20
Mu Bufaransa

Mu bindi bihugu → Ibanki Mpuzamahanga (International Bank) Nimero ya Konti (IBAN):

IBAN
FR 16 20041 01008 1822226V029 88

→ N' Inyandikobanga ya banki (BIC) :

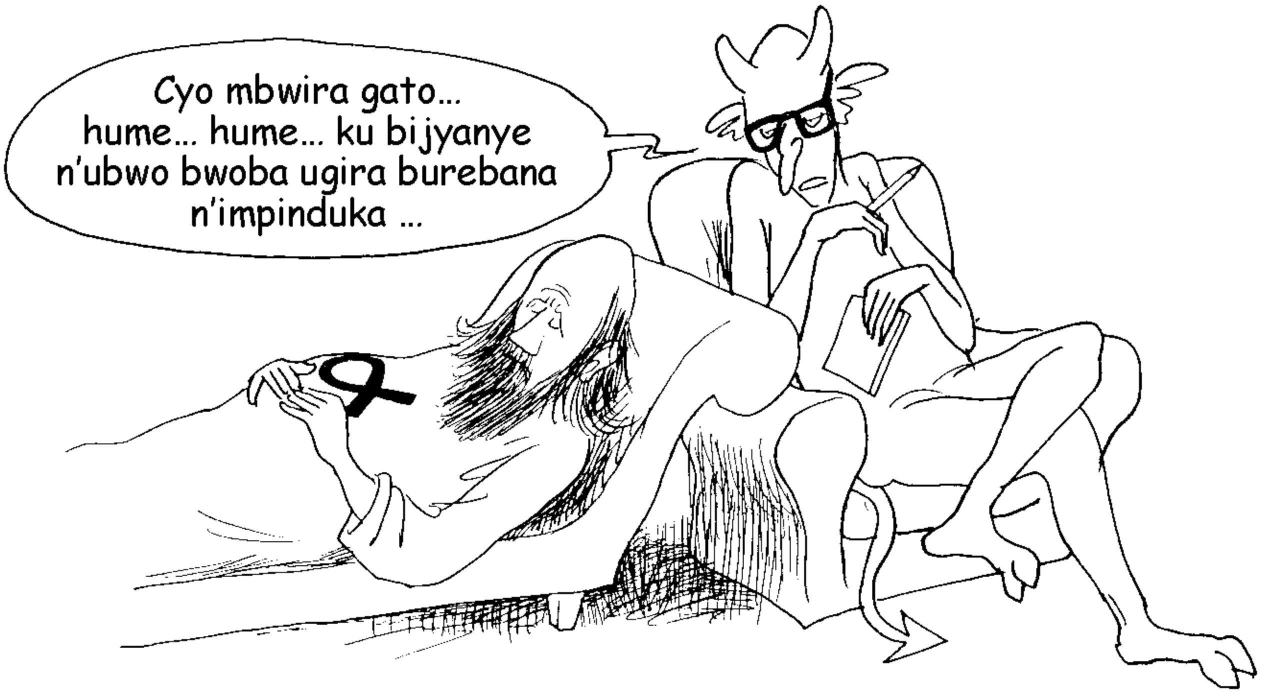
BIC
PSSTFRPPMAR

Amategeko agenga iri shyirahamwe agaragara ku rubuga rwa yo kuri interineti. Imibare ngaragaza mutungo nayo irahari kandi ihora ishyirwa ku gihe. Iri shyirahamwe nta mafaranga na make rikura ku nkunga rihawe uretse ayo kohereza, bicishijwe muri banki, ahemba abahinduranyi b'indimi ku buryo babona abagenewe yose.
Nta munyamuryango w'iri shyirahamwe n'umwe rihemba kuko bose ari abakoranabushake.
Abanyamuryango ubwabo nibo barihira amafaranga ishyirahamwe rikoresha ngo ribeho nk'ayo kwishyura no gukoresha urubuga rwa yo rwo kuri interineti kuko ayo atarihwa n'ishyirahamwe.
Bityo mugaragarizwa neza uko umutungo w'ishyirahamwe ukoreshwa kandi mukibonera ikizere ko, muri iyo "mirimo y'ubwitange mfashamuco", inkunga yose mutanga ikoreshwa neza mu kwishyura abahindura ibitabo mu zindi ndimi.
Dushyira ku rubuga rwa interineti buri kwezi, ugereranije, nk'ibitabo cumi bihinduwe mu zindi ndimi.

Ubumenyi butagira Imipaka

Bigi Bange

Johani-Petero Petit



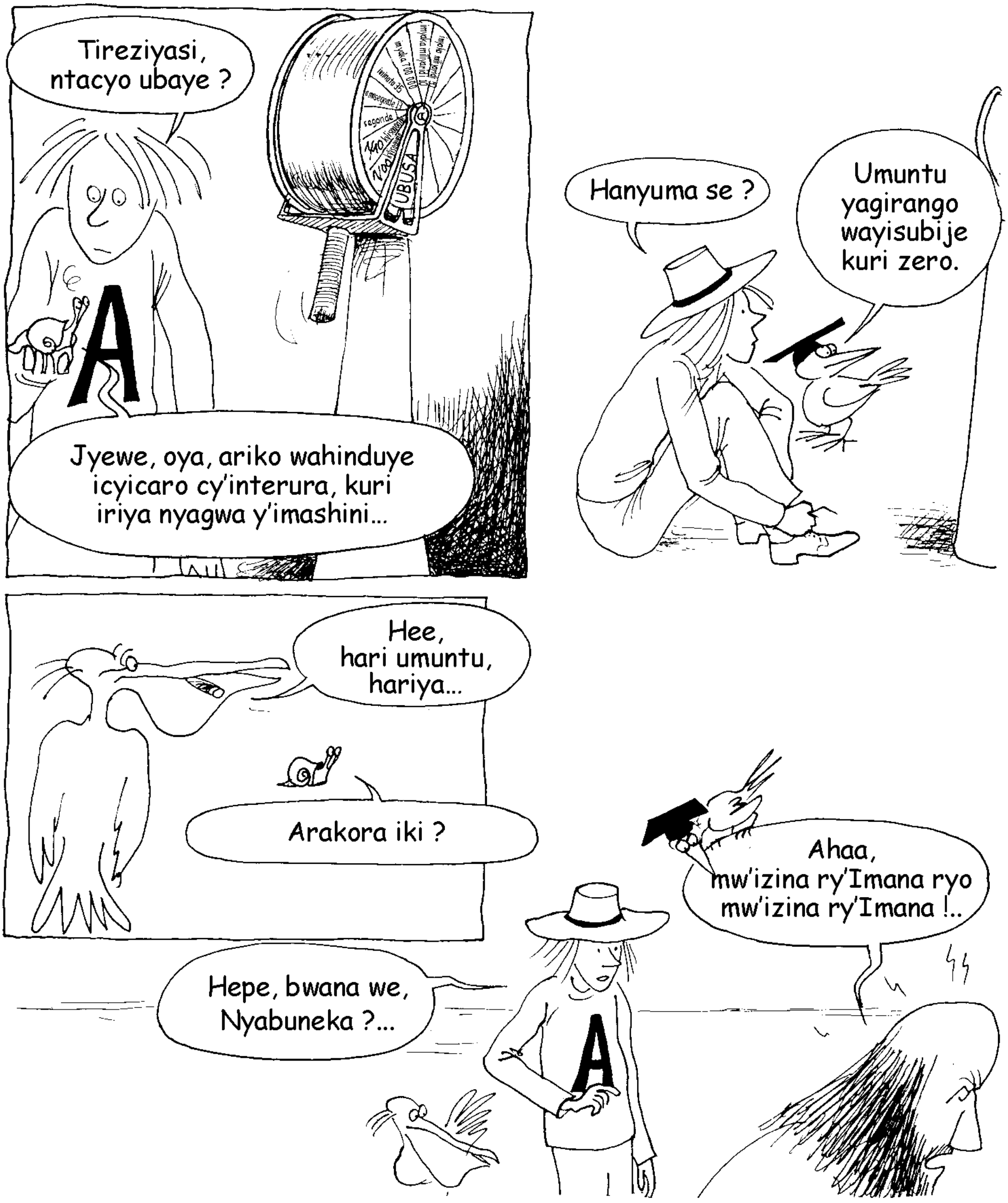
Byahinduwe na :
Mohamed Abdel aziz Kamanzi

http://www.savoir-sans-frontieres.com

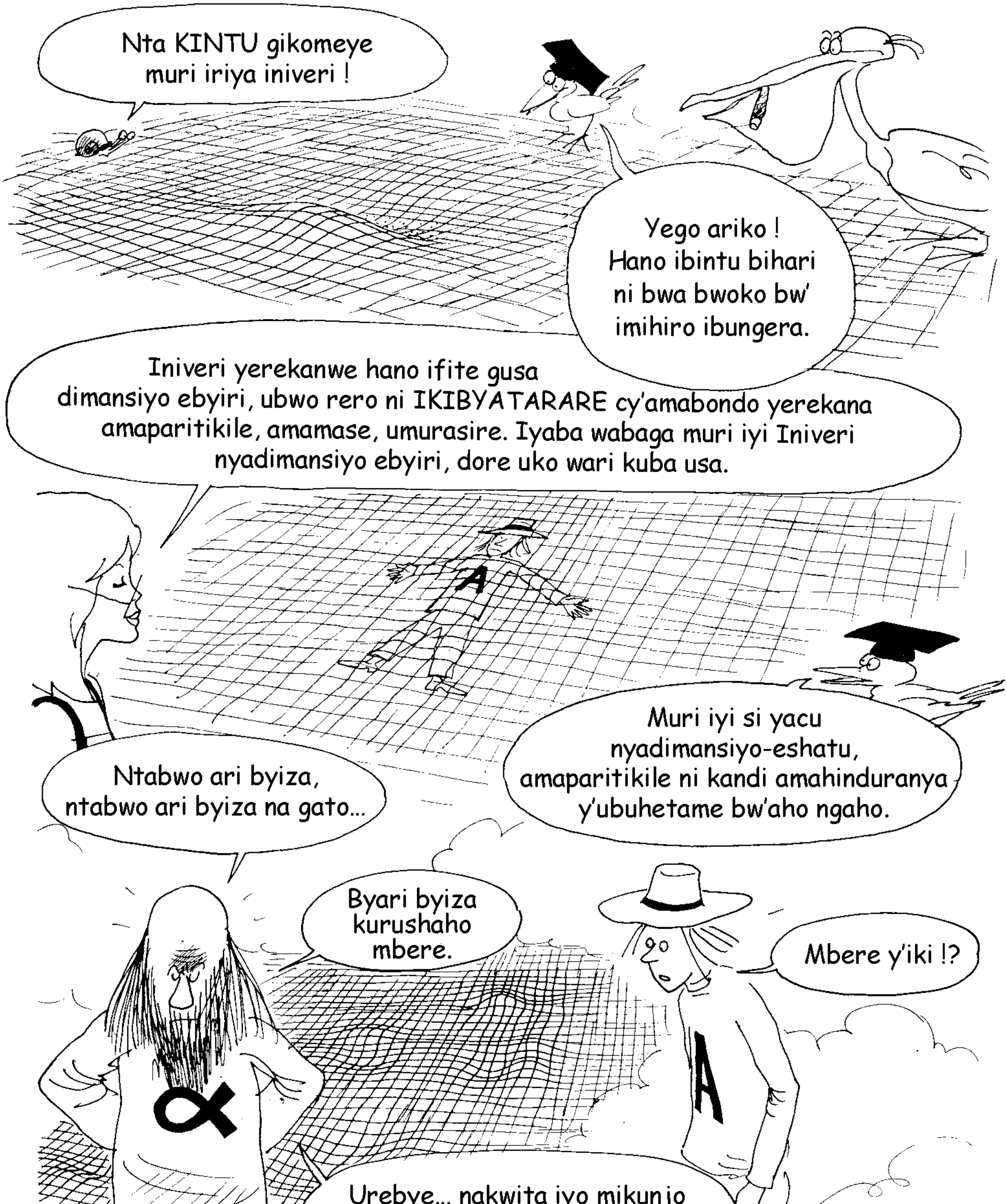
iNKOMOKO Y'iNKURU

Ariko se icyo kiburagasani ni kintu nyabaki ?
UBUNGUBU
imyaka 700 000
iminota 35
amasegonde 13
i segonde 1
1/10 kyisogonde
1/100 kyisogonde
UBUSA
AMAGEZA ARIHO ARAKORWA NTUKOREHO
Wagirango ni ikintu cyo mu bwoko bwa KORONOTORONI.
Ziriya ndasago... ntimubonako ziteye amakyenga ?
AKO KANYA...
Tireziyasi, ikure aho ngaho vuba !!!
Mi !!!!
KOLONGE !

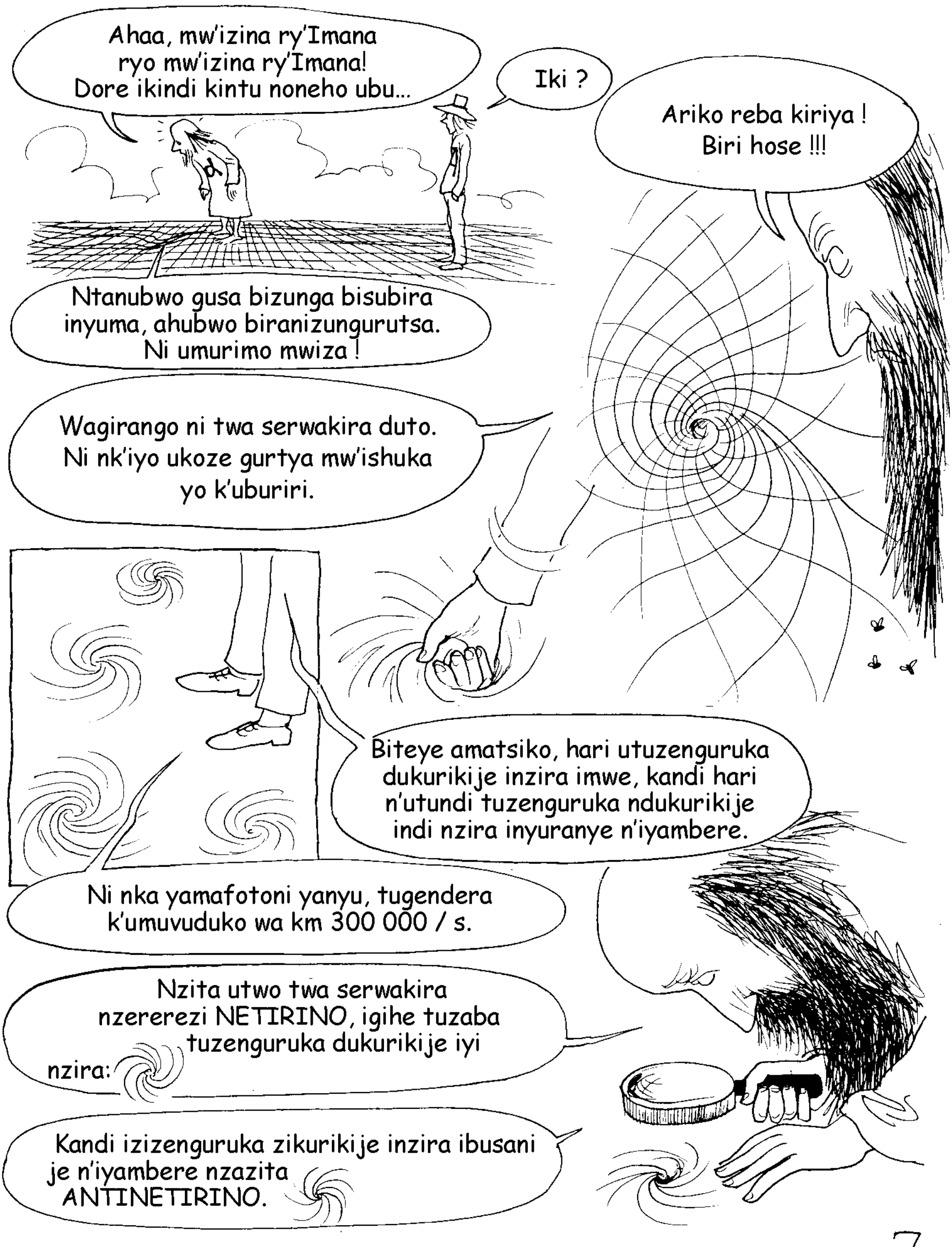
ITANGIRIRO RYA BYOSE



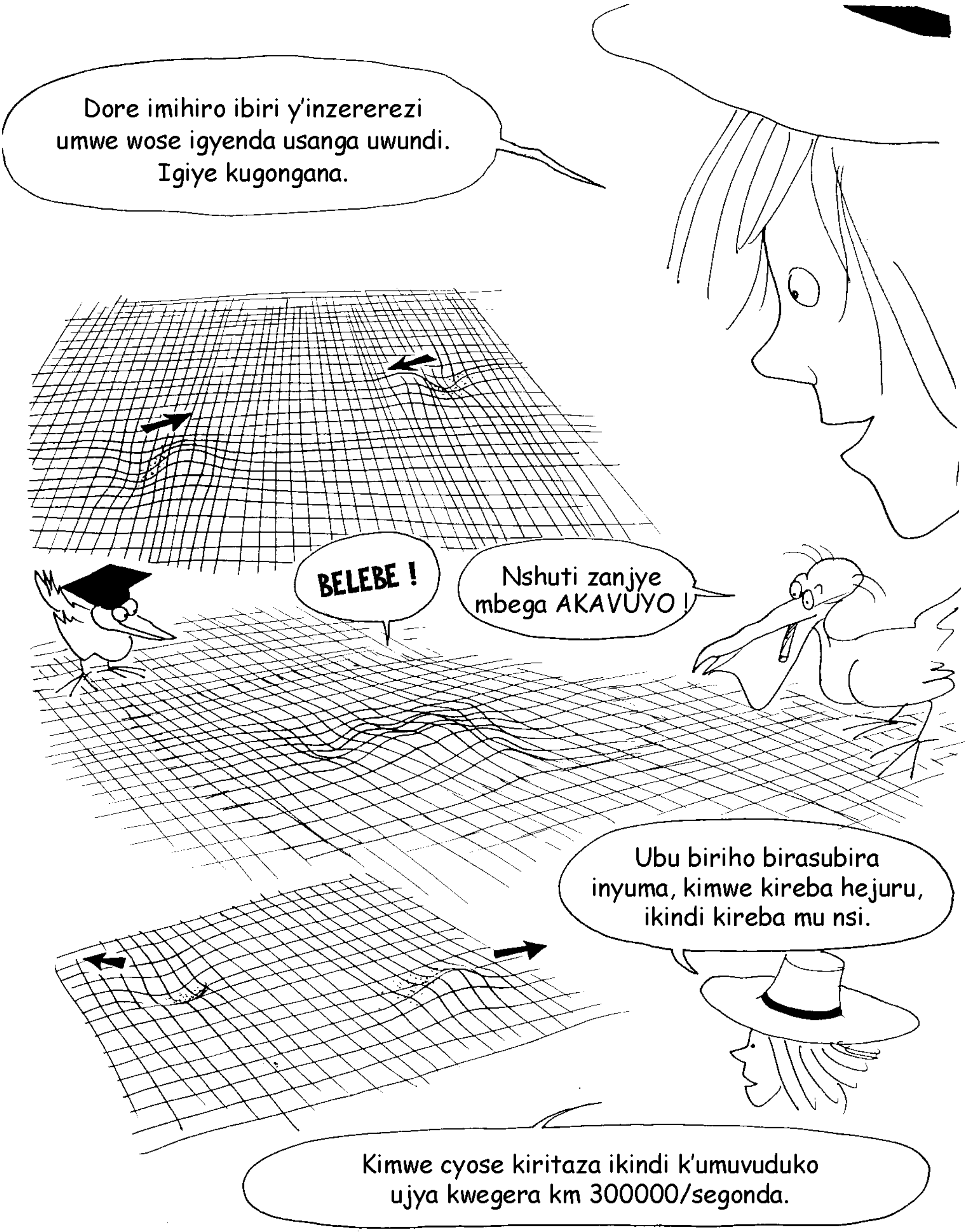
Ngu ko, byanze kandi !
Nishyize mu kagozi...
Nimba ari umusambi mugerageza kurambura, murabyifatamwo nabi, kandi uko ni ukuri !
Inshuti ya nyu, irasa nifite ibibazo yatewe n'uriya musambi we.
Mbega amakuba... imikunjo ahantu hose !..
Ni ibisanzwe ko haza imikunjo. Mwashatse gushyiraho myinshi. Umusambi wiyegeranije...
Tisisii... iyo hatabaho itsindagira nta mbaraga zari kuhaboneka: hari kuba hari esipase gusa...
Iyaba byari bitsindagiye kimwe hose ! ariko hari ahari amatsinda y'imikunjo, abungera uko yishakiye hirya no hino ntagahunda, k'umuvuduko wa kilometero ibihumbi magana atatu kw'isegonde.
Ibyo ni kwantikye... ni nk'idayimoni rya kwantikye...
Ni iki ?..



Nta KINTU gikomeye muri iriya iniveri !
Yego ariko ! Hano ibintu bihari ni bwa bwoko bw' imihiro ibungera.
Iniveri yerekanwe hano ifite gusa dimansiyo ebyiri, ubwo rero ni IKIBYATARARE cy'amabondo yerekana amaparitikile, amamase, umurasire. Iyaba wabaga muri iyi Iniveri nyadimansiyo ebyiri, dore uko wari kuba usa.
Muri iyi si yacu nyadimansiyo-eshatu, amaparitikile ni kandi amahinduranya y'ubuhetame bw'aho ngaho.
Ntabwo ari byiza, ntabwo ari byiza na gato...
Byari byiza kurushaho mbere.
Mbere y'iki !?
Urebye... nakwita iyo mikunjo nzererezi, AMAFOTONI.


Ahaa, mw'izina ry'Imana ryo mw'izina ry'Imana! Dore ikindi kintu noneho ubu...
Iki ?
Ariko reba kiriya ! Biri hose !!!
Ntanubwo gusa bizunga bisubira inyuma, ahubwo biranizungurutsa. Ni umurimo mwiza !
Wagirango ni twa serwakira duto. Ni nk'iyo ukoze gurtya mw'ishuka yo k'uburiri.
Biteye amatsiko, hari utuzenguruka dukurikije inzira imwe, kandi hari n'utundi tuzenguruka ndukurikije indi nzira inyuranye n'iyambere.
Ni nka yamafotoni yanyu, tugendera k'umuvuduko wa km 300 000 / s.
Nzita utwo twa serwakira nzererezi NETIRINO, igihe tuzaba tuzenguruka dukurikije iyi nzira:
Kandi izizenguruka zikurikije inzira ibusani je n'iyambere nzazita ANTINETIRINO.

(*) Imyitwarire y'icyo bita UMURASIRE W'IKINTU CYIRABURA (satani azi impamvu...)


Dore imihiro ibiri y'inzererezi umwe wose igyenda usanga uwundi. Igiye kugongana.
BELEBE !
Nshuti zanjye mbega AKAVUYO !
Ubu biriho birasubira inyuma, kimwe kireba hejuru, ikindi kireba mu nsi.
Kimwe cyose kiritaza ikindi k'umuvuduko ujya kwegera km 300000/segonda.

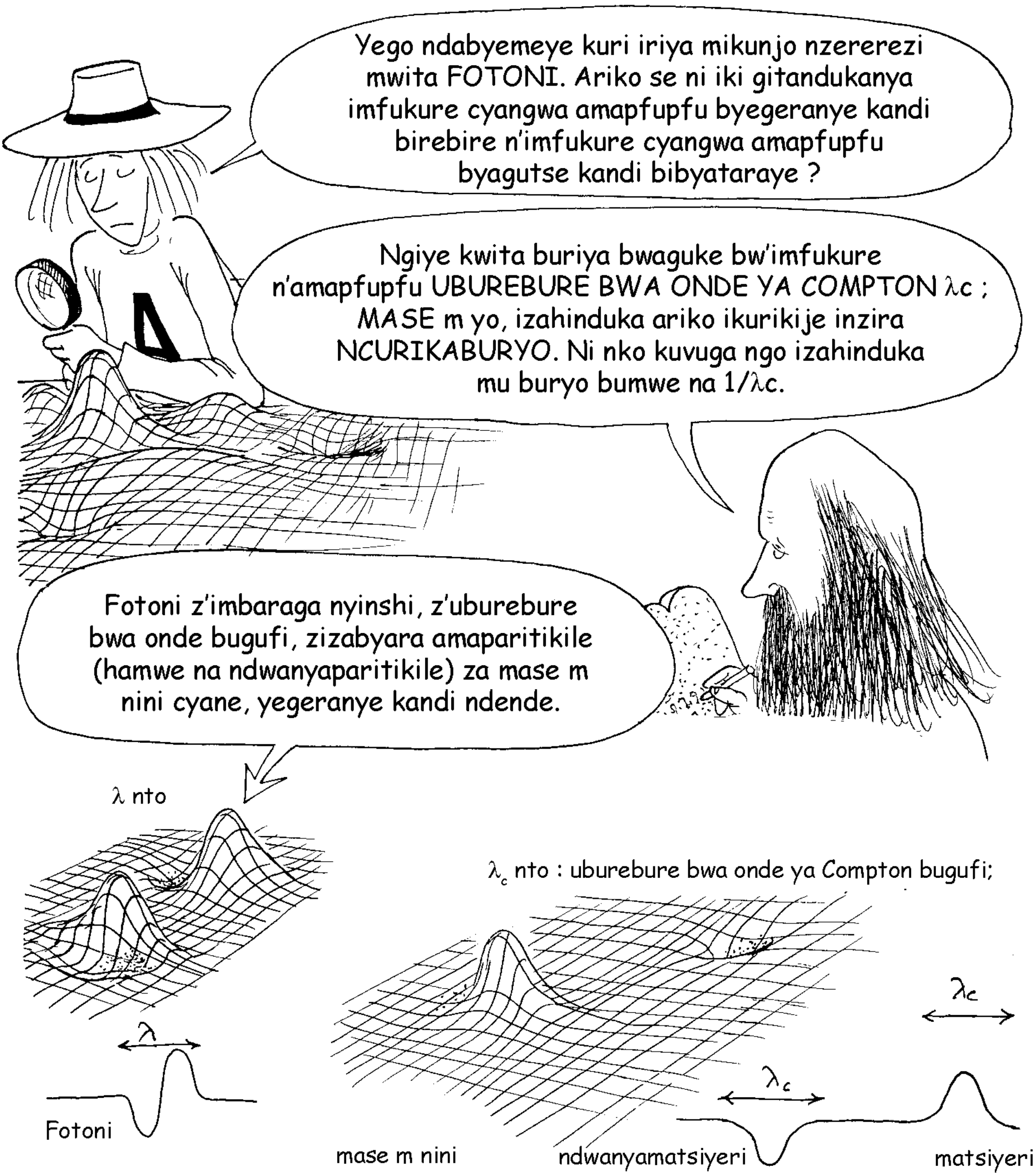
Byiza. Nzita amapfupfu MATSIYERI, naho ibifukuye INDWANYAMATSIYERI. Hariho u BUHETAME, ni ukuvuga MASE.
Fotoni yo irafukuye kandi ni ipfupfu, ubwo rero ni paritikile ubwayo kandi ikongera ikaba indwanyaparitikile yayo bwite.
MATSIYERI n' INDWANYAMATSIYERI, byaturutse mw'isekurana ry'amafotoni, bigaragarana imivuduko nyarolativite.
ipfupfu, imfukure, ibyo byose ni ibyitiriro.
Nshuti yanjye Tireziyasi, ni ikihe gisobanuro cy'icyo gitekerezo kirekire ? Hari ibintu bigaragara nk'imfukure n'ibindi nk'amapfupfu. Ibyo bibonwa na buri wese...
Ni uko turi kuri uru ruhande rw'umusambi. Iyo tuza kuba turi k'urundi ruhande, amapfupfu yahinduka imfukure; naho imfukure zigahinduka amapfupfu.
Ariko... jye ndabona uruhande rumwe gusa !!!
Tireziyasi !!!

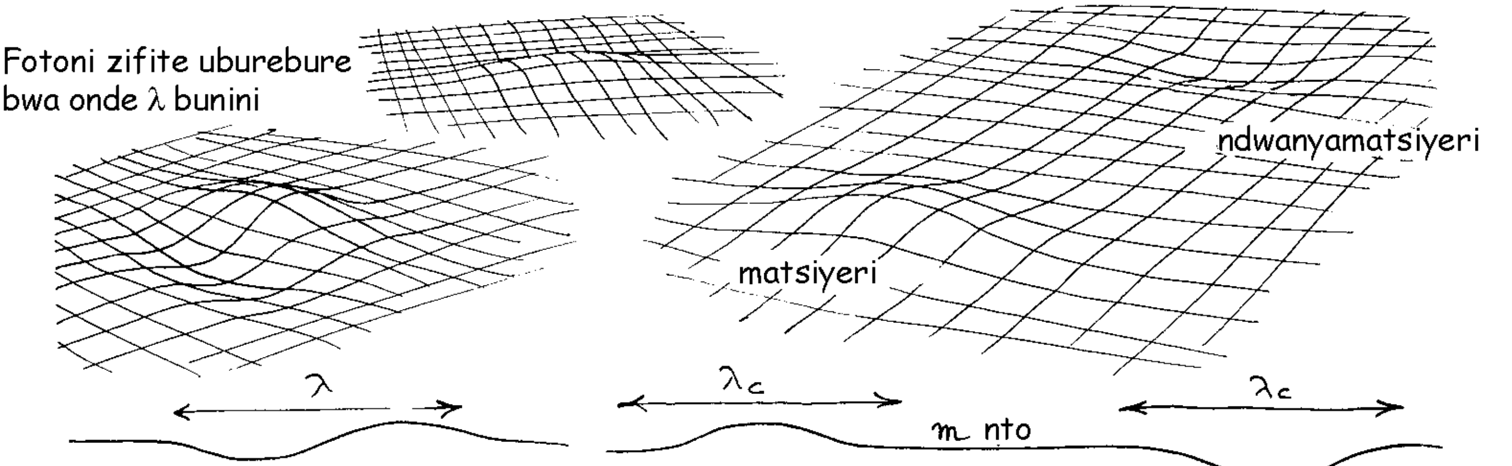
(*) umucunzi wa Episitemoloji: Episitemoloji: imyigire k'ubumenyi Umucunzi w'ubumenyi.

(*) reba BIBIRIYA

Nzita λ, UBUREBURE BWA ONDE naho indeshyo y'imikunjo nzererezi, ama FOTONI
Reka dutekereze ko nkoze umuhiro nzererezi igihe nyeganyeje uyu mugozi. Ubwambere ndawuzunguza buhoro, nkoresheje imbaraga nkye noneho ubwo uburebure bwa onde λ buba burebure.
Ubu noneho reka nyeganyeze cyane uyu mugozi, ni nongera IMBARAGA ziwunyeganyeza, uburebure bwa λ buzaba buguvi pe ugereranije n'ubwambere.
Ye !
K'uburyo rero, uko onde ijyenda itwaye imbaraga ni nako uburebure bwa yo buba bugufi.
Nzavuga ko imbaraga zitwawe na FOTONI, akamanyu k'URUMURI,zizajyenda zihinduka MU NCURIKABURYO ugereranije n'UBUREBURE BWA ONDE λ: E ihinduka bu burtyo bumwe na 1/λ
Birtyo, bizakunda ...

UKO BiBA BiTO Ni NAKO BiREMERA CYANE

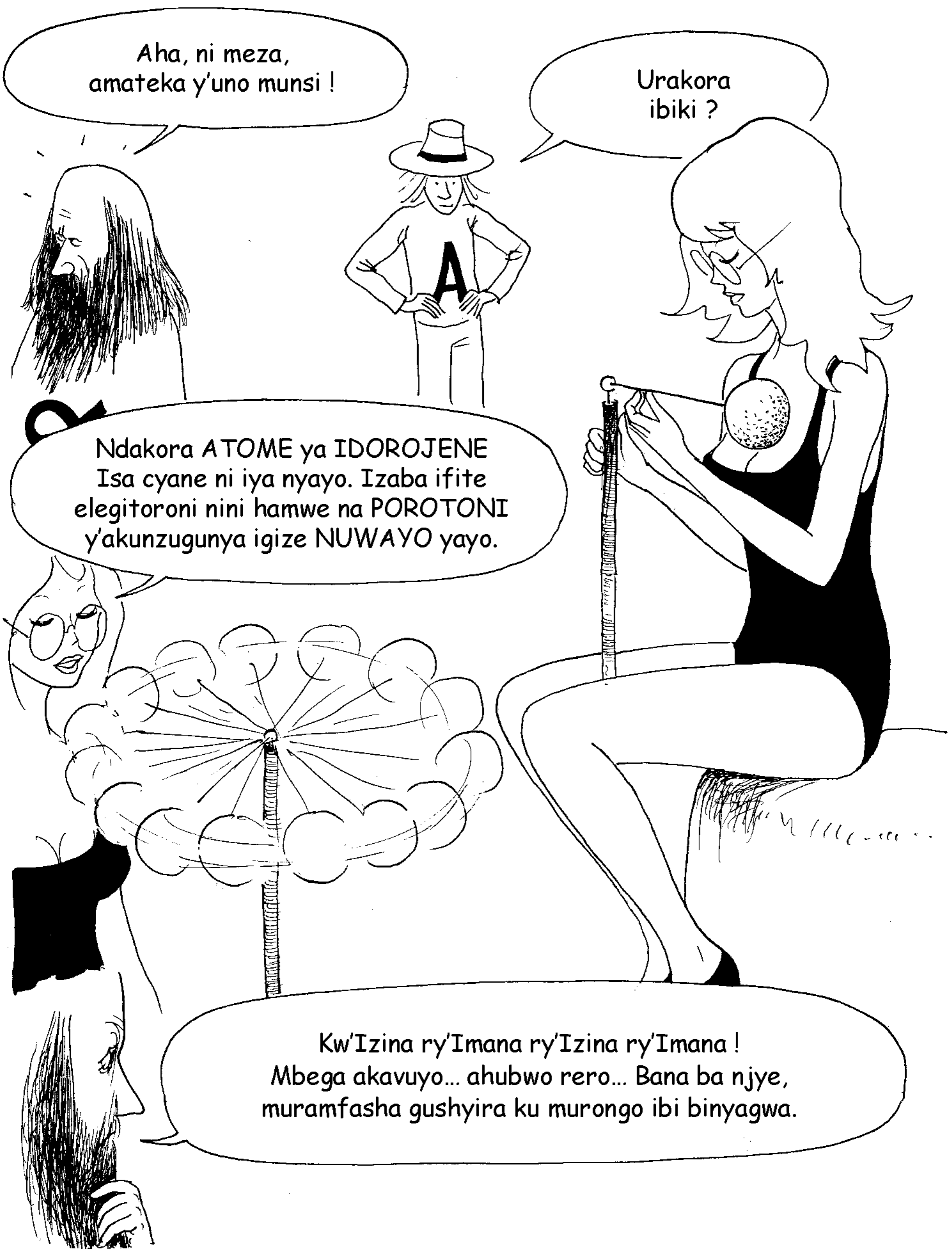




Fotoni zifite uburebure bwa onde bunini → paritikile zifite uburebure bwa onde ya Compton bunini.

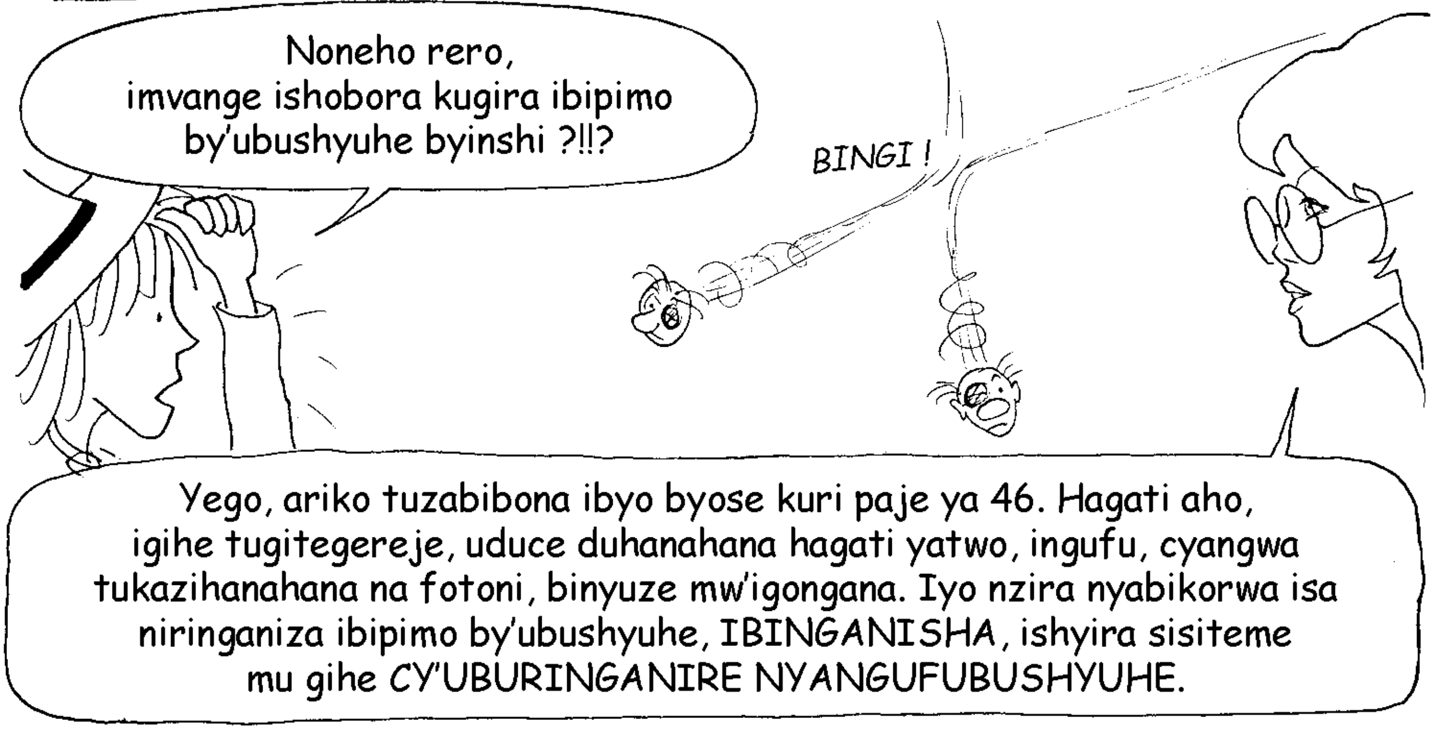
(*) twibuke ko E(ingufu) = m(mase). Reba BYOSE BIFITANYE ISONO.

Eheee, mube muretse ! hariho ikintu kidasobanutse muri iyo nkuru yose ! Ntakigenda rwose...
OHE, MBABARIRA !
BINGI
POROTONI na NETORONI zifite mase zijya kungana. Zifite RERO umubyimba umwe. Ariko elegitoroni yo ifite uburemere bukye cyane.Mu by'ukuri, yakagombye kuba ari ... Nini kuzirusha !?!
Rwose neza. POROTONI na NETORONI bipima kg $1,66.10^{-27}$ imwe yose; elegitoroni ipima kg $9,1.10^{-31}$. Rero ifite uburemere buto cyane. Ni icya rimwe ku 1850 cya kimwe cyose: ni ukuvugako ikubye imwe yose inshuro 1850 mu "bunini".
Jye... eh... uuh la la...
Hari ubwo wari bwabone porotoni, wowe ?
Ehi... OYA...
Nonese !


Aha, ni meza, amateka y'uno munsi !
Urakora ibiki ?
Ndakora ATOME ya IDOROJENE Isa cyane ni iya nyayo. Izaba ifite elegitoroni nini hamwe na POROTONI y'akunzugunya igize NUWAYO yayo.
Kw'Izina ry'Imana ry'Izina ry'Imana ! Mbega akavuyo... ahubwo rero... Bana ba njye, muramfasha gushyira ku murongo ibi binyagwa.

IGIPIMO CY'UBUSHYUHE BW'UMURASIRE T_R

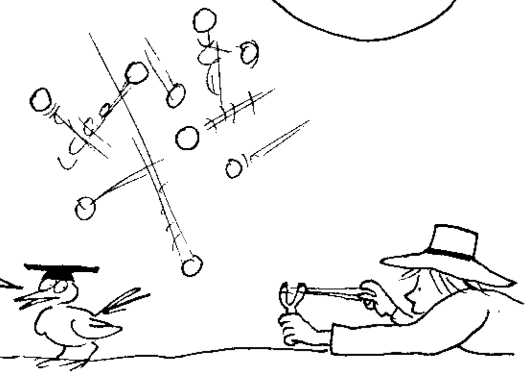
IGIHE CY'UBURINGANIRE



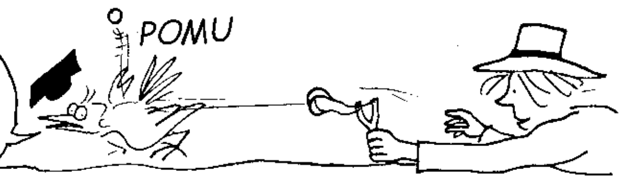
UBUSHYUHE BWA MATSIYERI

T_M

Izo paritikile NYAMATSIYERI zose zifite mase m n'imivuduko V binyuranye. INGUFU NYAMUVUDUKO za paritikile nyamatsiyeri zingana na $\frac{1}{2}MV^2$. Ariko, kuri iryo tsinda, nshobora gusobanura ingufu ry'itingisa (NYABUSHYUHE) ryo hagati na hagati.



Kandi UBUSHYUHE BWA MATSIYERI T_m buzaba igipimo cy'izo NGUFU ZO HAGATI NA HAGATI RY'ITINGISA NYABUSHYUHE.

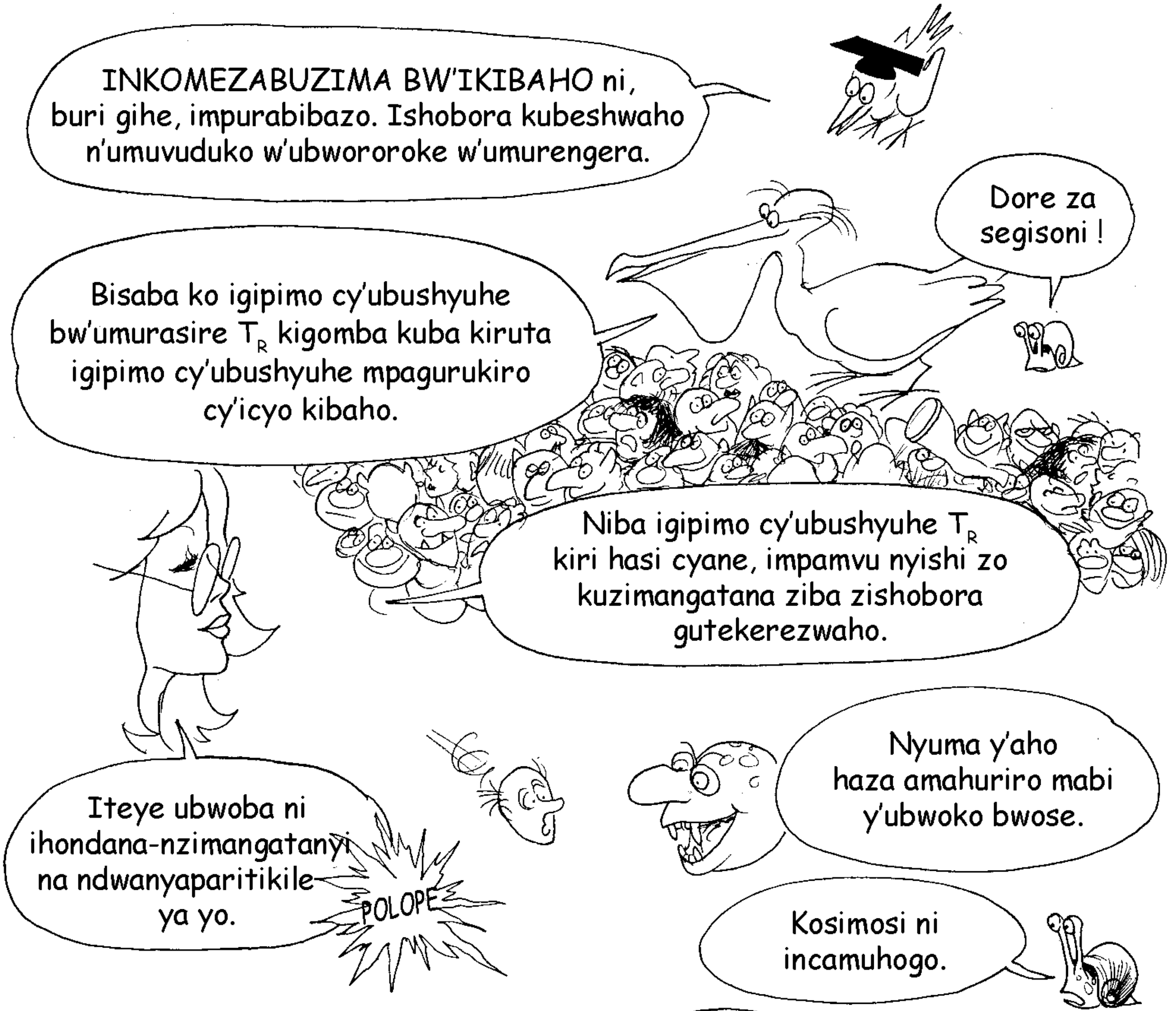


NYANGUFUBUSHYUHE

Iyo paritikile ifite ingufu nyishi, iyo yihuta cyane, iyo "ishyushye" cyane, isekurana n'iyindi paritikile rigabanya umuvuduko wa yo. Bigenda birtyo no mu ncurikaburyo iyo igyenda buhoro cyane. Niba iyo fenomene yo guhuza ingufu y'ibintu binyuze mwisekurana ari nini cyane bihagije, si ubushyuhe bwonyine buzaringanira gusa, ahubwo buzaguma bucyo naho wagabanya volime y'iyo vange cyangwa wayikwedura.

UBUSHYUHE BW'iBANZE

ITERAMBERE RY'UBWOKO BW'IBIBAHO



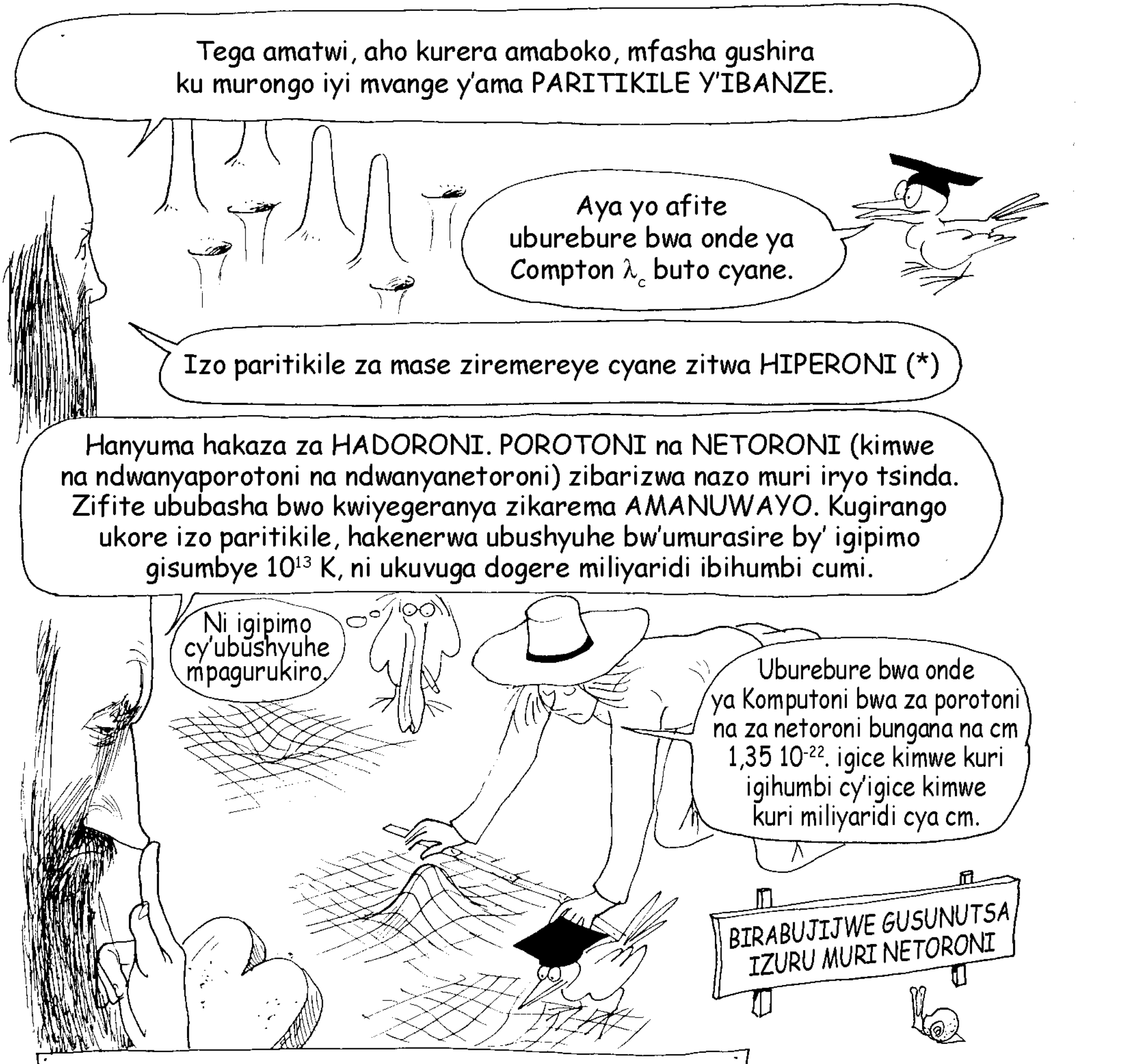
Mugusoza mbabwire ko amaparitikile afite UBURAMBE BW'UBUZIMA (*) bwabwo bwite. Icyo gihe iyo kirangiye, ayo maparitikile yihindura ubwayo mu yandi maparitikile akanatanga umurasire.

(*) ... ikigega cya byo cya KORONOLE.
Reba IBINTU BYOSE BIFITANYE ISANO

Ese ubu ubushyuhe buri ku kihe gipimo ?
Fata fotoni noneho upime uburebure bwa onde bwa yo λ !
Itanure ry'itanure, dogere miliyari ibihumbi makumyabiri (2x10^13 K)
Bisa naho hari umubare ungana wa fotoni, wa netirino, wa porotoni, wa netoroni, wa elegitoro (na za ndwanyaparitikile za zo).
Ku gipimo cy'ubushyuhe bw'umurengera nk'uwo, buri kintu cyose ni ROLATIVISITE. N'izo paritikile nyamatsiyeri zigendera ku mivuduko yegeranye n'umuvuduko w'urumuri c.
Muri IBINTU BYOSE BIFITANYE ISANO, twari twabonye ko iyo umuvuduko wa paritikile usatira umuvuduko w'urumuri, IGIHE NYAKURI cya yo gihagarara nk'umufa.

(*) igihe nyakosimosi gishobora kuba umwanya wo hagati na hagati w'IBIHE NYAKURI.

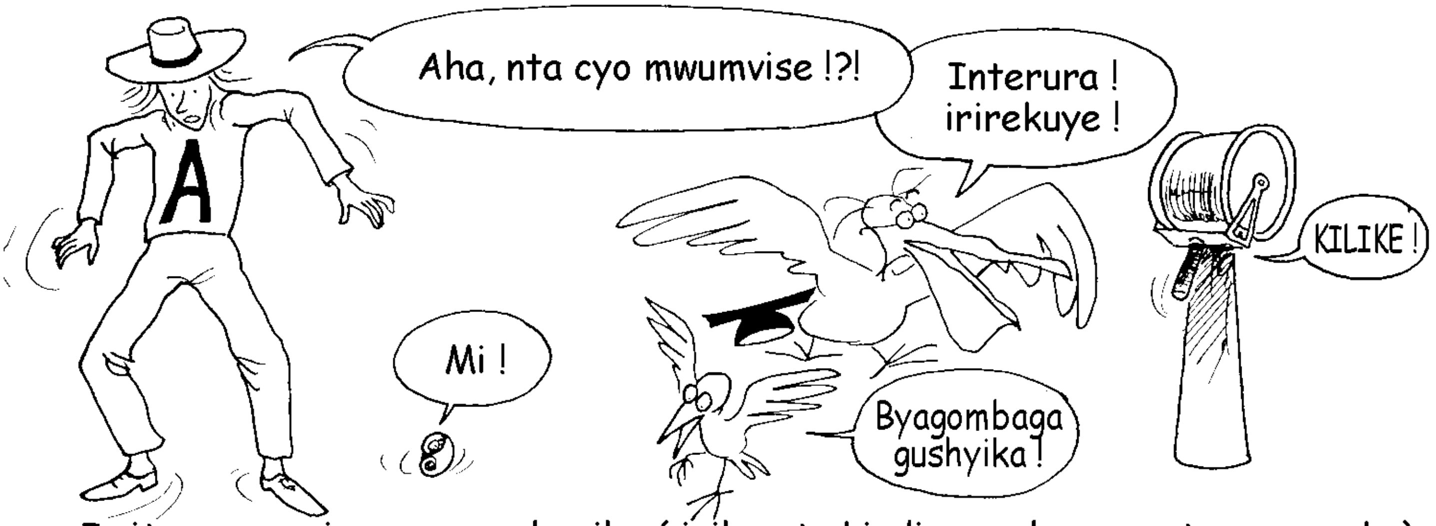
PARITIKILE Z'IBANZE



(*) Ibaho rya byo nta kiryemeza, hashingiye k'ubumenyi tugezeho muri iki gihe.

(*) bituruka mu kigiriki LEPTOS, kinanutse.

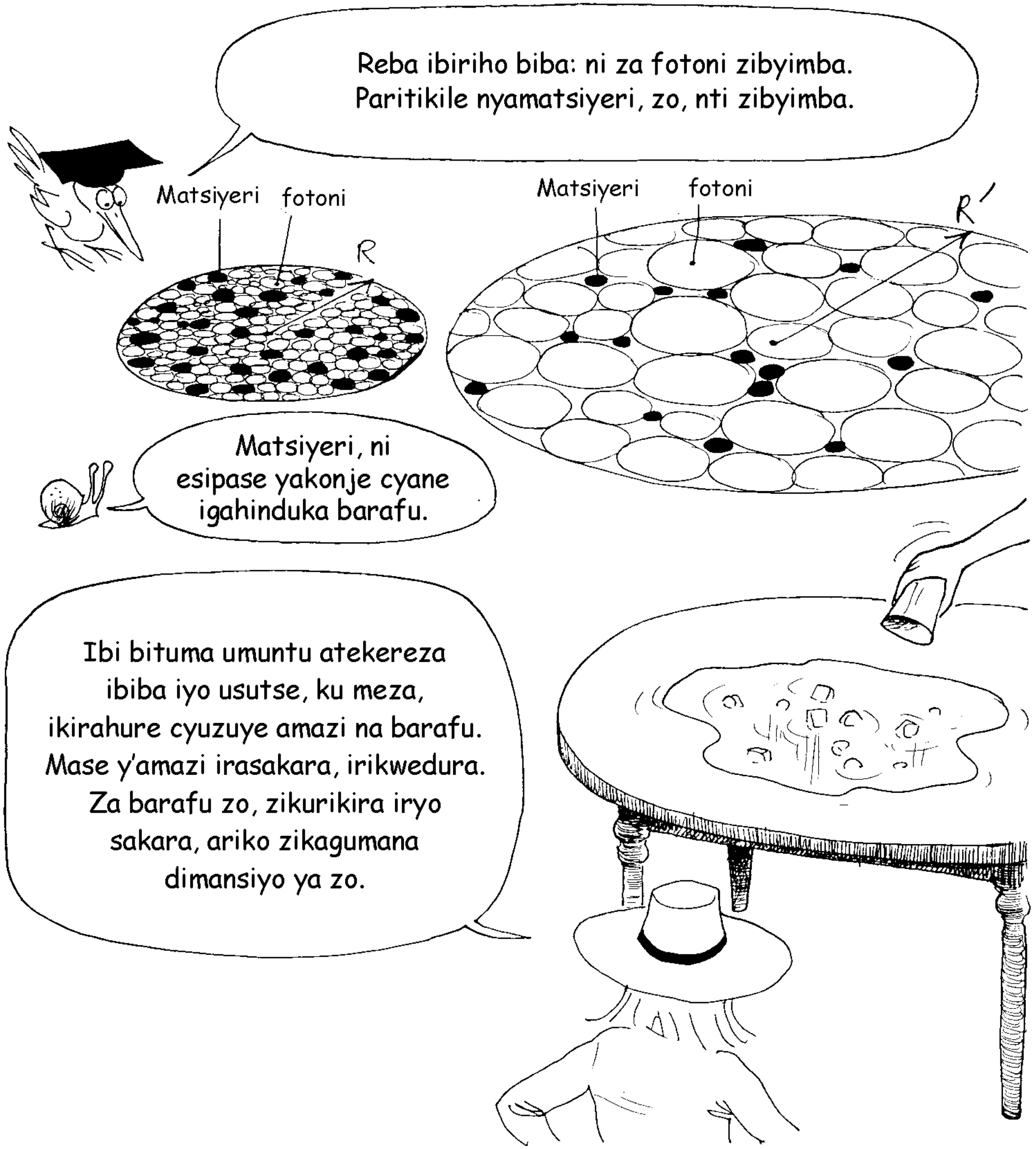
BYOSE BIRIGENDEYE



Imiterere yari, cyane, nsabagihe (igihe nta kindi cyasabaga uretse guseruka). Koronotoroni itangira gukora ubwo rero EVENOMA yambere iba irabaye, UMWANYA wambere.

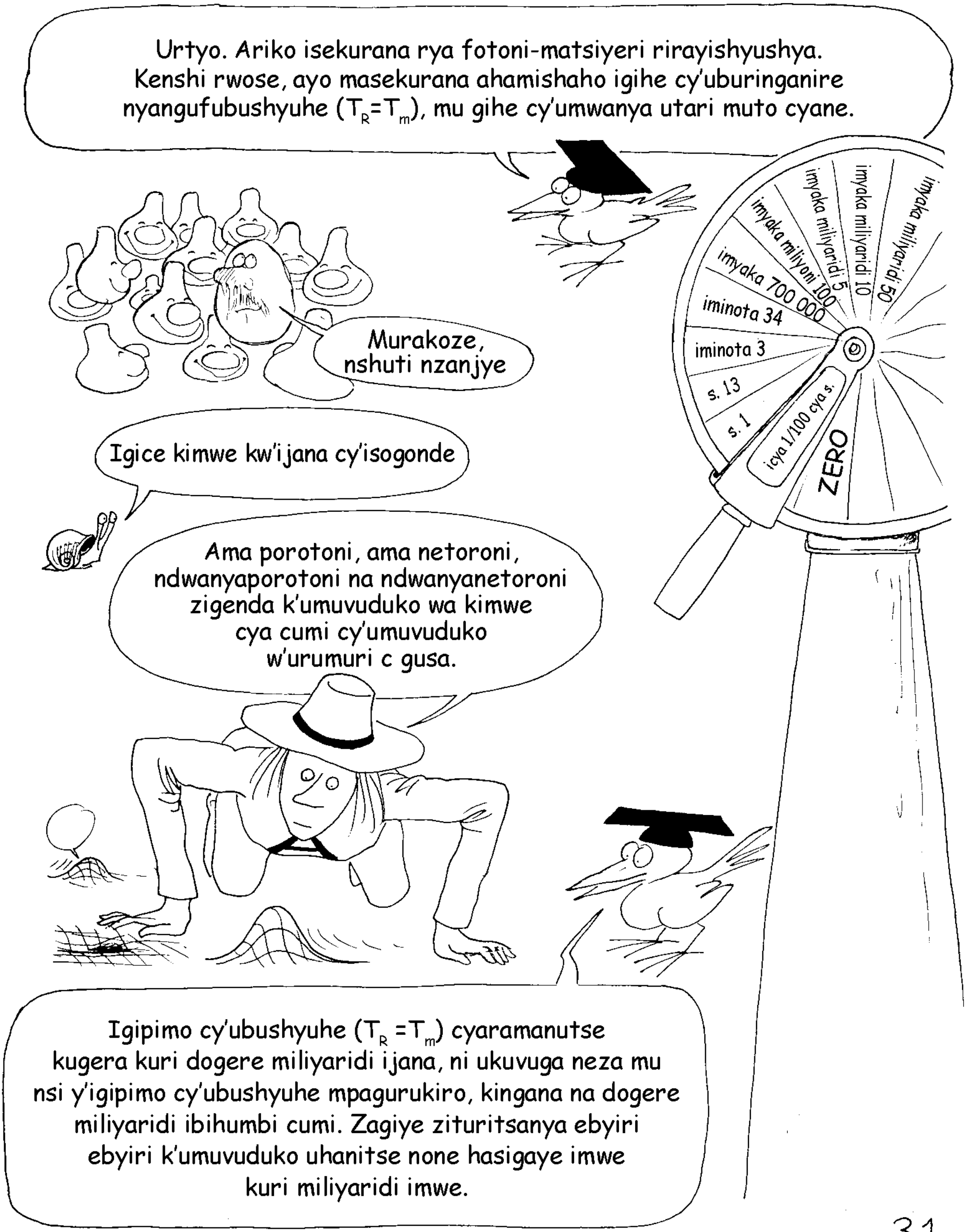
Muri hehe ?
Ni ibiki bibaye ?
Ni IKWEDUKA, ishwiragira...
Iniveri irikweduye. Mbabarira...
Nigiriye ahandi.
Impinduka, jye, sinyihanganira!
Ehee !!!
Ni ukuri, arabidutanye ngo bidupfane.
Muraza kubibona, mu gihe gito biraza koroha gato.
Murabeho
imikomereze myiza.
Byapfuye kandi!
Ese yaciye he ?
Umuntu yagirango ni ibipfundikizo bya ruhurura. Ese byaba ari amarimbi ya za Iniveri?

UBUDAHINDUKA BWA MASE



(*) biturutse kuri kosimosi: COSMOS na topos: AHANTU (ahantu Iniveri yicaye.)

Dore igishushanyo cyerekana neza ikururuka
rya fotoni n'itakaza ry'ingufu rihakomoka.
Ariko se matsiyeri yifata ite muri iryo kweduka ?
Iniveri ininda esipase nk'uko igishishwa cy'igi gikorwa. Uko igihe gihita ni nako paritikile zibona inzira yo kunyuramwo. Iyo ingano ya Iniveri yikubye kabiri, umuvuduko wo kwitingisa w'ama paritikile nyamatsiyeri ugabanukaho icya kabiri. Ingufu nyarugendo za byo zigabanywa rero na 4: umuvuduko wo kwitingisa uhinduka nk'incurikamubare ya reyo R ya Iniveri, birtyo rero igipimo cy'ubushyuhe T_m bwa matsiyeri buhinduka nka $1/R^2$.
Ariko... twabonye mu kanya ko ubushyuhe bw'umurasire T_R gihinduka nka 1/R. Matsiyeri ifite rero umuco wo gukonja vuba ?
Uuhu ndananiwe..



Urtyo. Ariko isekurana rya fotoni-matsiyeri rirayishyushya. Kenshi rwose, ayo masekurana ahamishaho igihe cy'uburinganire nyangufubushyuhe ($T_R=T_m$), mu gihe cy'umwanya utari muto cyane.
imyaka miliyaridi 50
imyaka miliyaridi 10
imyaka miliyaridi 5
imyaka miliyoni 100
imyaka 700 000
iminota 34
iminota 3
s. 13
s. 1
icya 1/100 cya s.
ZERO
Murakoze, nshuti nzanjye
Igice kimwe kw'ijana cy'isogonde
Ama porotoni, ama netoroni, ndwanyaporotoni na ndwanyanetoroni zigenda k'umuvuduko wa kimwe cya cumi cy'umuvuduko w'urumuri c gusa.
Igipimo cy'ubushyuhe (T_R =T_m) cyaramanutse kugera kuri dogere miliyaridi ijana, ni ukuvuga neza mu nsi y'igipimo cy'ubushyuhe mpagurukiro, kingana na dogere miliyaridi ibihumbi cumi. Zagiye zituritsanya ebyiri ebyiri k'umuvuduko uhanitse none hasigaye imwe kuri miliyaridi imwe.

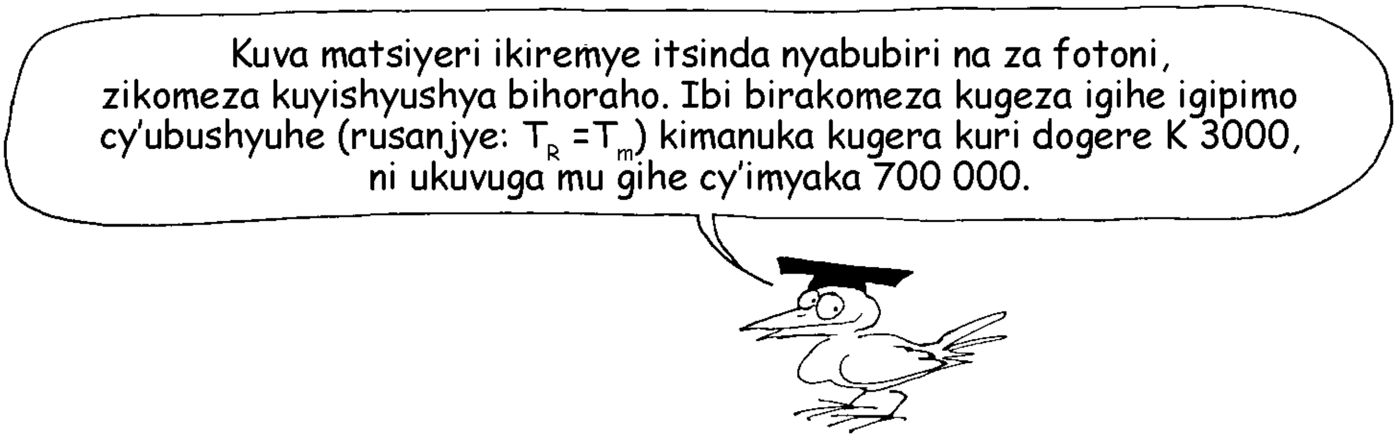
Sofiya, porotoni, netoroni, ndwanyaporotoni na ndwanyanetoroni nyinshi zarayonze. Ariko se kuki elegitoroni na positoroni (ndwanya-elegitoroni) zingana zirtya zo zasigaye ?
Igipimo cy'ubushyuhe mpagurukiro bwa za elegitoro kingana na miliyaridi esheshatu za dogere gusa.
miliyari esheshatu za dogere gusa... urumva ?
Twavuga ko bitanga amafu.
Hari ikintu kidasobanutse: igipimo cy'ubushyuhe ni dogere miliyaridi ijana. Za porotoni, netoroni, ndwanyaporotoni na ndwanyanetoroni zigenda k'umuvuduko wa kimwe cya cumi cy'uw'urumuri. Ariko elegitoroni zo ziracyari rolativisite.
Yego, kubera iki ?

Aho hantu haracyari buri gihe mu nteruro y'UBUNGANISHA NYABUSHYUHENGUFU:Irematsinda nyabubiri rya za esipese zose, hamwe n'umurasire, ni inyakarindi buri gihe. Ingufu z'umuvuduko z'amaparitikile nyamatsiyeri zingana, ufatiye hagati na hagati, na :
$\frac{1}{2} M_{porotoni} (V_{porotoni})^2 = \frac{1}{2} M_{elegitoroni} (V_{elegitoroni})^2$
Buretse... nk'uko mase ya elegitoroni iri nto inshuro 1850 ugereranije n'iya porotoni, rero ni ukuvugako, nta shidikanya ko, kugirango hazibwe icyuho, ku igipimo cy'ubushyuhe kanaka, umuvuduko wo kwitingisa wa elegitoroni ari munini cyane.
Ubireba, nk'uko ingufu-hagurukiro kugirango hakorwe paritikile ya masse m ari nkuko bisanzwe mc^2 gusa, kuva umuvuduko wo kwitingisa V ubaye nk'ugaragara muto cyane kuri c, ikorwa ry'ayo ma paritikile rirahagarara kandi n'igabanuka ry'imiturire rikikora.
Mu yandi magambo: kuva itsinda rya za paritikile nyamatsiyeri riretse kuba rolativisite, iryo tsinda rirahona.

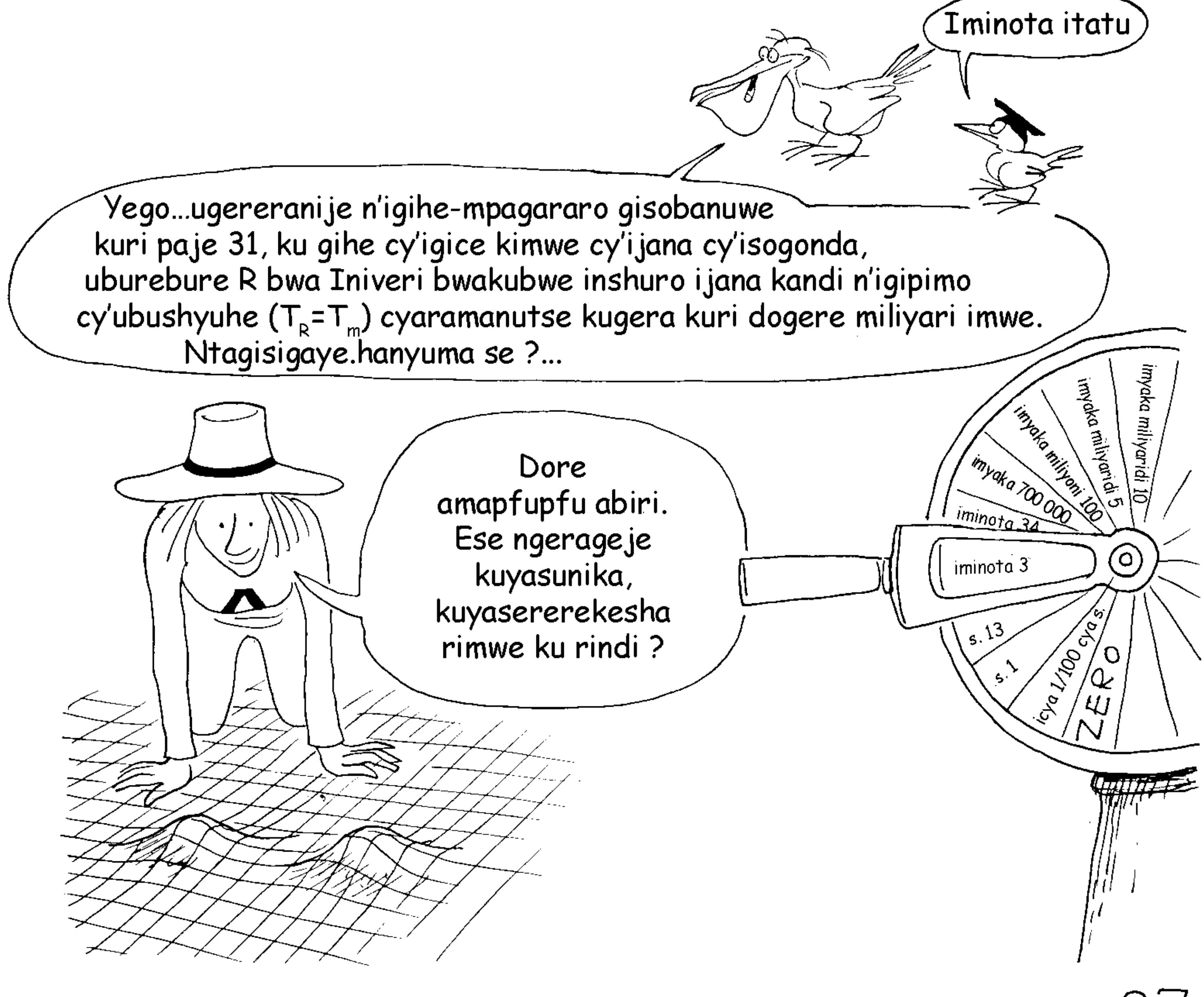
Amasegonde cumi na tatu.
Igipimo cy'ubushyuhe cyaragabanutse kugera kuri dogere miliyaridi eshatu.
imyaka miliyaridi 10
imyaka miliyaridi 3
imyaka miliyoni 100
imyaka 700 000
iminota 34
iminota 3
s. 13
s. 1
icya 1/100 cya s.
ZERO
Ahe, reba za elegitoroni na za ndwanyelegitoroni. Mbega irigita-honero !
Ni ibisanzwe, turi mu nsi y'igipimo cy'ubushyuhe hagurukiro.
Ihonero nyaryo nyakosimikye ryagereranywa n'iryitiriwe umutagatifu Baritelemi !
Hariya naho kandi, hazasigara gusa imwe kuri MILIYARIDI !
Mbega amakuba...

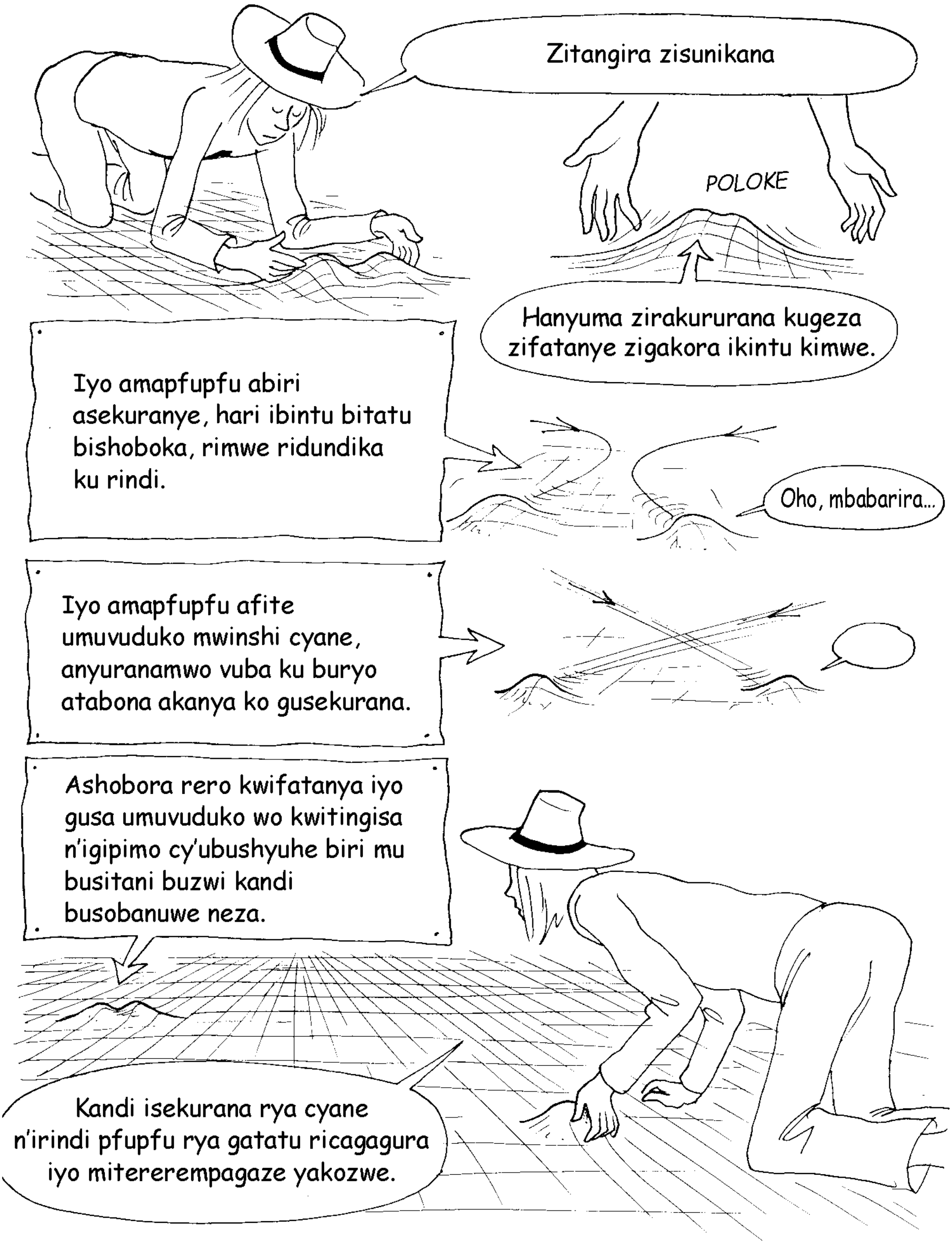
(*) Alubomu imwe izaba by'umwihariko ijyanye n'intera z'ibitekerezo birengeye.
" IBIRORI BY'UBUMENYI: Ikusanyo ry'ibitekerezo byo mu bihe birimbere"

IBIHE BY'IMIRASIRE ITWIKANA
Ama paritikile, hari UBUSHYO bwa yo.
Nta kintu gitangaje muri iyi Iniveri usibye urumuri
INGUFU-MATSIYERI, byari mu migabane ingana mu foruma ya matsiyeri, ndwanyamatsiyeri k'uruhande rumwe, fotoni na netirinosi k'urundi; byabaye ubu rukumbi mu foruma ya fotoni na netirinosi, ni ukuvuga iforuma y'imirasire. Mu busanzwe, buri gihe iyo uburebure bwa Iniveri bwikubye kabiri, dansite ya matsiyeri iragabanuka. Ni kuyonga bisanzwe.
Ku musambi, iyo R yikubye kabiri, dansite yo igabanuka ku nshuro 2x2 = 4. Muri Iniveri yacu nyadimansiyo eshatu, mu by'ukuri, iyo dansite igabanuka ku nshuro 2x2x2 = 8.
Indemere ya matsiyeri ihinduka nk'incurikaburyo ya kyibe y' "uburebure" bwa "reyo" ya Iniveri.
Ariko, kuri twebwe, amafotoni, ni agateramakuba. Iryo kweduka "rituvomamwo" buhoro buhoro ingufu zacu zose. Inganamubare y'ingufu-matsiyeri tujyendana igabanuka nk'incurikaburyo ya reyo R ya Iniveri.
Ibyo bituma dansite y'ingufu-matsiyeri iri mu foruma ya fotoni ihinduka nk'incurikaburyo y'inkubabubasha ya kane ya R.



iREMWA RY'AMANiKELEWO





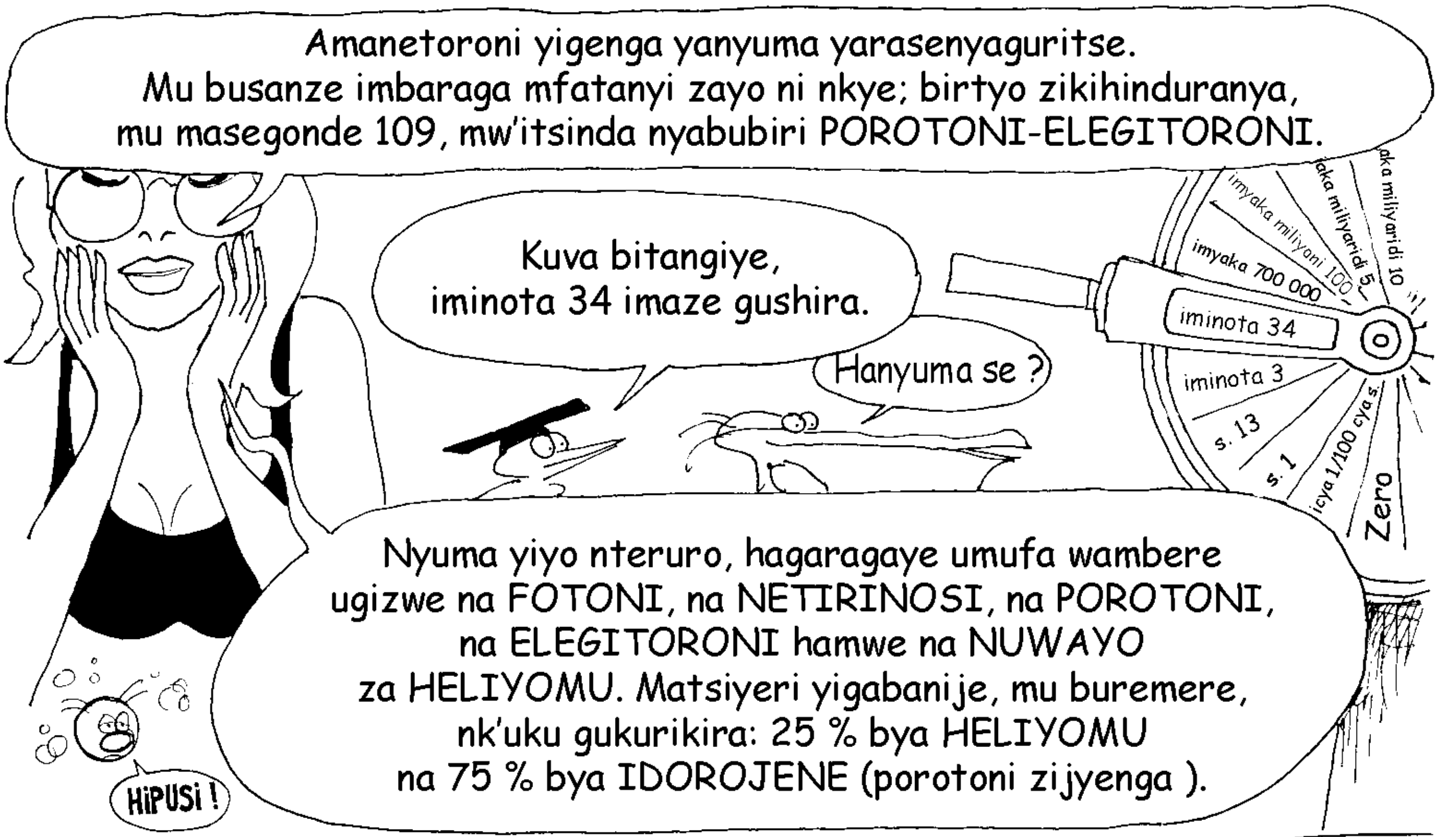
Zitangira zisunikana
POLOKE
Hanyuma zirakururana kugeza zifatanye zigakora ikintu kimwe.
Iyo amapfupfu abiri asekuranye, hari ibintu bitatu bishoboka, rimwe ridundika ku rindi.
Oho, mbabarira...
Iyo amapfupfu afite umuvuduko mwinshi cyane, anyuranamwo vuba ku buryo atabona akanya ko gusekurana.
Ashobora rero kwifatanya iyo gusa umuvuduko wo kwitingisa n'igipimo cy'ubushyuhe biri mu busitani buzwi kandi busobanuwe neza.
Kandi isekurana rya cyane n'irindi pfupfu rya gatatu ricagagura iyo mitererempagaze yakozwe.

Izo nsubizabikorwa z'IMATANISHA zitanga AMANUWAYO ya mbere ya z'ATOME. Iyo MORUFOJENEZE izaserura AMAFORUMA ya mbere, IMITEREREMPAGAZE ya mbere ya Iniveri.
A
Iyo nkuru, irasekeje cyane. Hagomba kubaho imbaraga nkurura n'imbaraga nsunika. K'uburebure bugari, imbaraga nsunika ziranesha, naho ku burebure bugufi ni imbaraga nkurura zinesha.
Ngiye gufata za sumaku nzishyire muri za siferi zikozwe muri muse.
Muse irika mu buryo bworoshye; ni ntsindagira ama siferi abiri imwe ku yindi, zisigara rero zifatana imwe ku yindi.
S N S N
Ngiye gushyira iyo mipira mu base nini yuzuye amazi...
.... Kugirango bishobore kugenda.

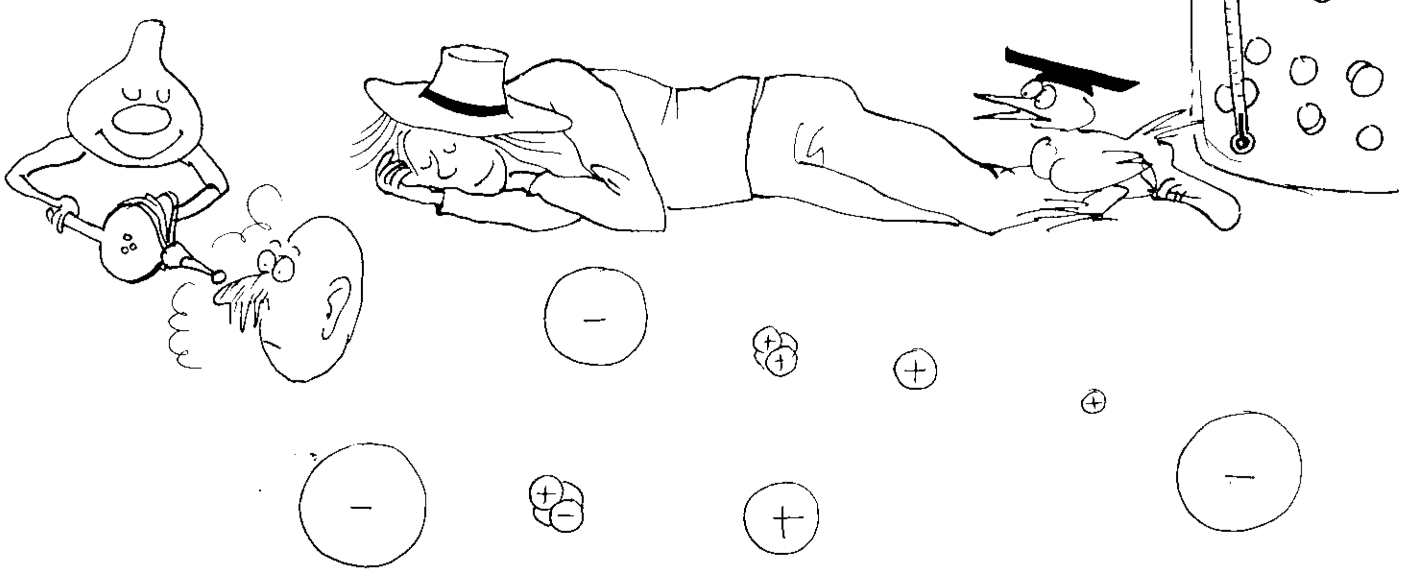
Imbaraga ebyiri zirigaragaza. Imwe ya nkurura: y'izo sumaku; indi mbaraga nsunika: ya muse iyo itsikamiwe. Iyo ya mipira ikoranyeho, za mbaraga zirigaragaza. Intera y'imbaraga nyasumaku aha ngaha iteye ku buryo muse igomba kuba itsindagiwe kugirango zigaragaze. Hari ahantu, hateye k'uburyo izo mbaraga zigeraho zikaringanira.
Muse iha ubwo bubumbe dansite ingana rwose n'iy'amazi. Noneho rero ubu naremye ivumbukangendo zo kwitingisa igihe mbishyuhije.
Igihe ubushyuhe ari buke, ayo mabule azadundika buhoro imwe ku yindi, ariko nta kindi kizaba. Iyo zisekuranye zirebana, nta mbaraga zihagije kugirango zitsindagire iyo muse, bishobore no gutuma imbaraga nyasumakumashanyarazi zigaragaza ku burebure bugufi, zikora.
Ni byiza, ngiye kongera ubushyuhe

Aho, birakunda! ni igipimo cy'ubushyuhe cyiza (kiruta igipimo cy'ubushyuhe MPAGURUKIRO). Intera yo kwitingisa irahagije.
Mu bigaragara, amabule aramatana abiri abiri.
Iyo nshyuhije cyane, iyo MITEREREMPAGAZE icibwa n'itingiswabushyuhe.
Hanyuma se mbikonjesheje ?
Anselimi areka umwuka usubira ibukonje. INYURANAMWO riragabanuka. Bigeze ahantu hamwe amabule amwe ariyegeranya mu matsinda nyabubiri. Ariko, igipimo cy'ubushyuhe gikomeza kugabanuka, iryo REMWA RY'AMANIKELEWO rirahagarara.
Nta kintu cya korwa, ubu ngubu. Harakonje cyane. Amabule ntiyitingisa bihagije kugirango ashobore kumatana abiri abiri.
Turi munsi ya MPAGURUKIRO

Ikintu nk'icyo cyaje kuba igihe igipimo cy'ubushyuhe bwa Iniveri cyamanukaga kikagera munsi ya dogere miliyaridi imwe. Ni ukuvuga nyuma y'IMINOTA mikye. Ubwo rero imitererempagaze nyabubiri, nyabutatu, cyangwa iy' "utubule" tune iriréma.



Mu gihe cy'imyaka 700000 nta kintu na gito cy'UBUNZUGUNYA kigeze kiba. Iniveri yakomeje kwikwedura, na fotoni nazo zigenza zicyo. Umwuka wa fotoni wakomeje guha ubushyuhe matsiyeri, kugirango ibipimo bibiri by'ubushyuhe T_R na T_M bigume bingana (uburinganire nyangufubushyuhe).

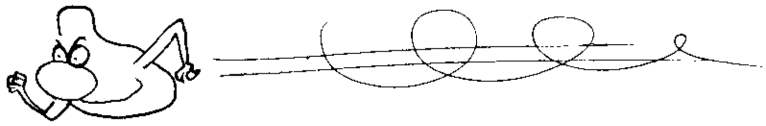


N'igipimo cy'ubushyuhe kiramanuka kugera kuri dogere Keluvine 3000.

iNiVERi iBONERANA

ISENYAGURIKA RY'IREMATSINDA NYABUBIRI NA RYO

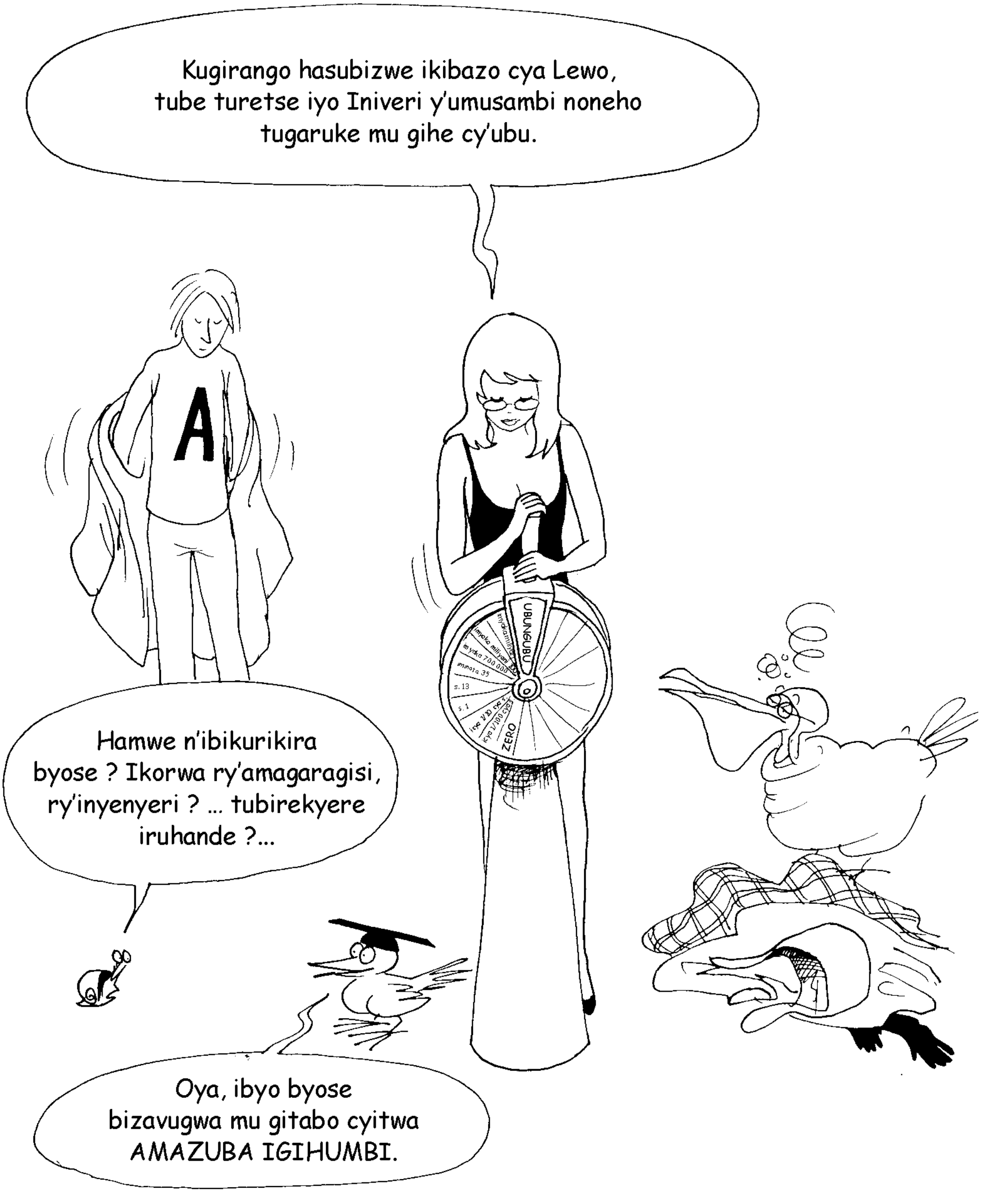
Ubu bya rangiye, amafotoni ashobora kwambukiranya Iniveri yose atanamenyeko matsiyeri ihari: habayeho ISENYAGURIKA RY' IREMATSINDA NYABUBIRI. Kubera impamvu ebyiri. Ubwa mbere umwanya urahari. Ubwa kabiri, amafotoni ahereranya ibikorwa gacye na matsiyeri mburamashanyarazi (atome).



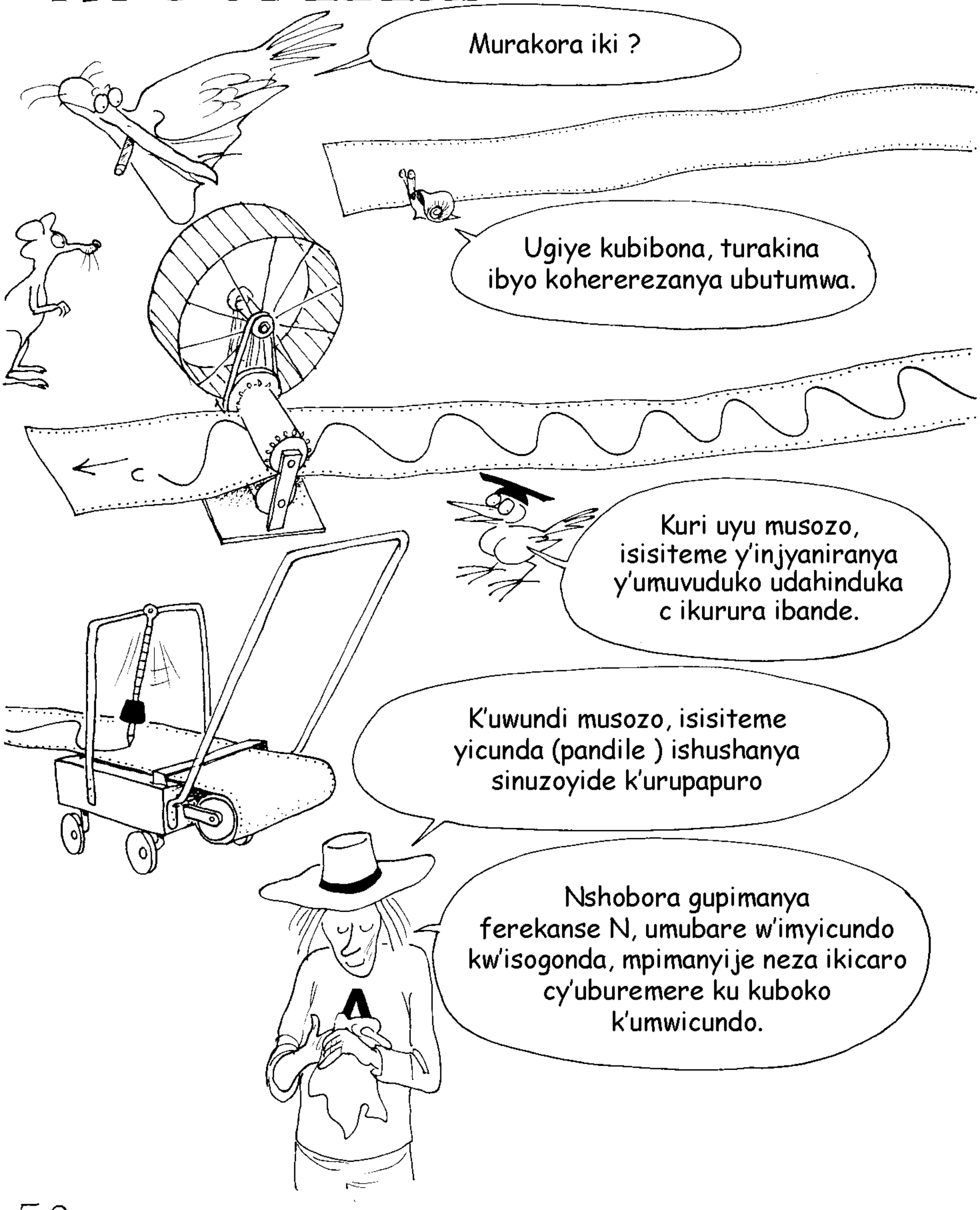
Matsiyeri na za fotoni byaje guhagarika guhererekanya ibikorwa, guhanahana ingufu, UBURINGANIRE MBARAGANYABUSHYUHE BWARASENYUTSE, noneho igipimo cy'ubushyuhe cya matsiyeri T_m cyahise kimanuka ni ngoga (nk'incurikaburyo y'inkububwacyo ya 2 ya reyo ya Iniveri), kurusha igipimo cy'ubushyuhe T_R cya fotoni, igipimo cy'ubushyuhe cy'umurasire, cyigabanuka gusa nk'incurikaburyo y'iyo reyo R.
Mwiriwe !
Ubu rero, umwe wese ni ukwimenya.
Bite ! habaye iki ? Wagirango ijoro riraguye ? Kandi hahise hakonja byabuze urugero, ako kanya...
imyaka miliyaridi 50
imyaka miliyaridi 10
imyaka miliyoni 100
imyaka 700 000
iminota 34
iminota 3
s. 13
s. 1
icya 1/100 cya s
Zero
Iniveri igiye mu gihe gisa n'umwijima. Ikomeje gukonja. Ijuru rihindura ibara riva kuri viyoleti rijya k'umutuku wijimye, hanyuma ijoro rigwa nk'ikiringiti gikonje. Buri gihe hari miliyaridi imwe y'amafotoni yo kw'isoko kuri buri atome ya heliyomu cyangwa ya hidorojene. Ariko ayo mafotoni, yakweduwe n'igara rya Iniveri, yataye agatege.
BIGI BANGE, byararangiye. Impinduka zabaye zarakabije. Habuze gato, nta cyari gusigara (iparitikile imwe kuri miliyaridi imwe !). harijimye cyane nko mu muhanda wo mu kuzimu.

Fucuturu, mbega ubukonje nk'ubwo mw'ishyamba !
Uburebure bwa onde ya za fotoni ni nka mm 0,15 , ni ukuvugako bujyanye n'igipimo cy'ubushyuhe bw'umurasire T_R = -173 °C.
Ama atome, yo, aritemberera k'umuvuduko wa m 150/s, ibyo bitanga igipimo cy'ubushyuhe bwa matsiyeri cya T_m = -267° C
Byiza, ndemeza ko nashoboye kumva uko Iniveri ikora.
Ariko hasigaye ikibazo k'ijyenzi: ese bimara iki?
Yego, Anselimi afite ukuri. Ubundi se ibyo bije bite ?
Ese byari ngirakamaro ?

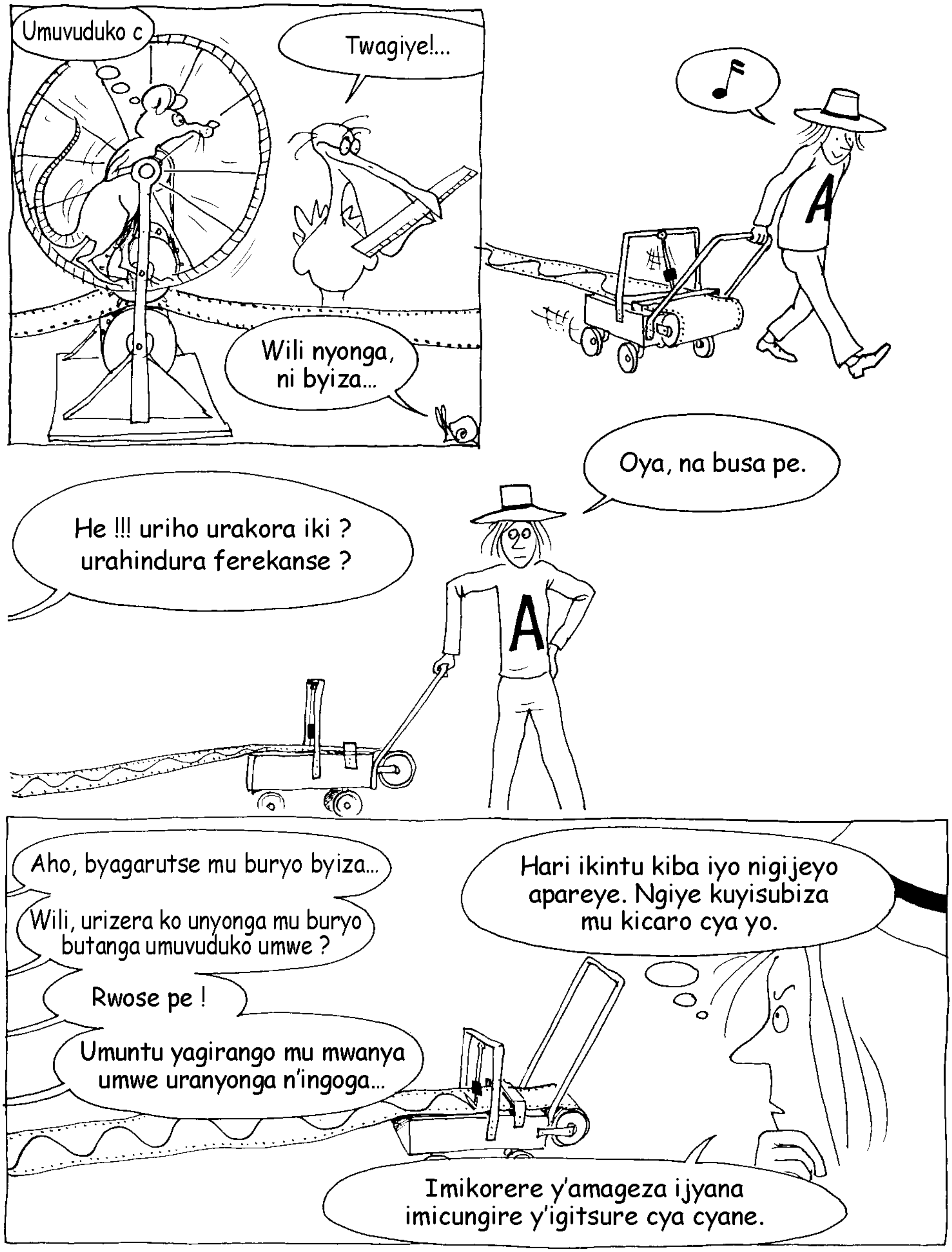
Reka turebe, bigitangira hari IBYARIBYO BYOSE mu kavuyo gahanitse.
AKAVUYO
Hanyuma Iniveri yatangiye gukora IMITEREREMPAGAZE yagendaga irushaho GUKOMERA, ama nuwayo, ama atome...
Na vumbuye ihame nyakosimosi ry'ibanze.
Aha... nonese ni iki ?
KUKI WAKORA IBYOROSHYE IGIHE WASHOBORA GUKORA IBIRUHIJE ?
Wayii... ntabwo ari kabi, ako gakuru ka we. Ariko ni ibyifuzo, indoto z'umuhanga mu gutekereza. Ni iki, kitubwirako byose koko byajyenze nk'uko nguko ?

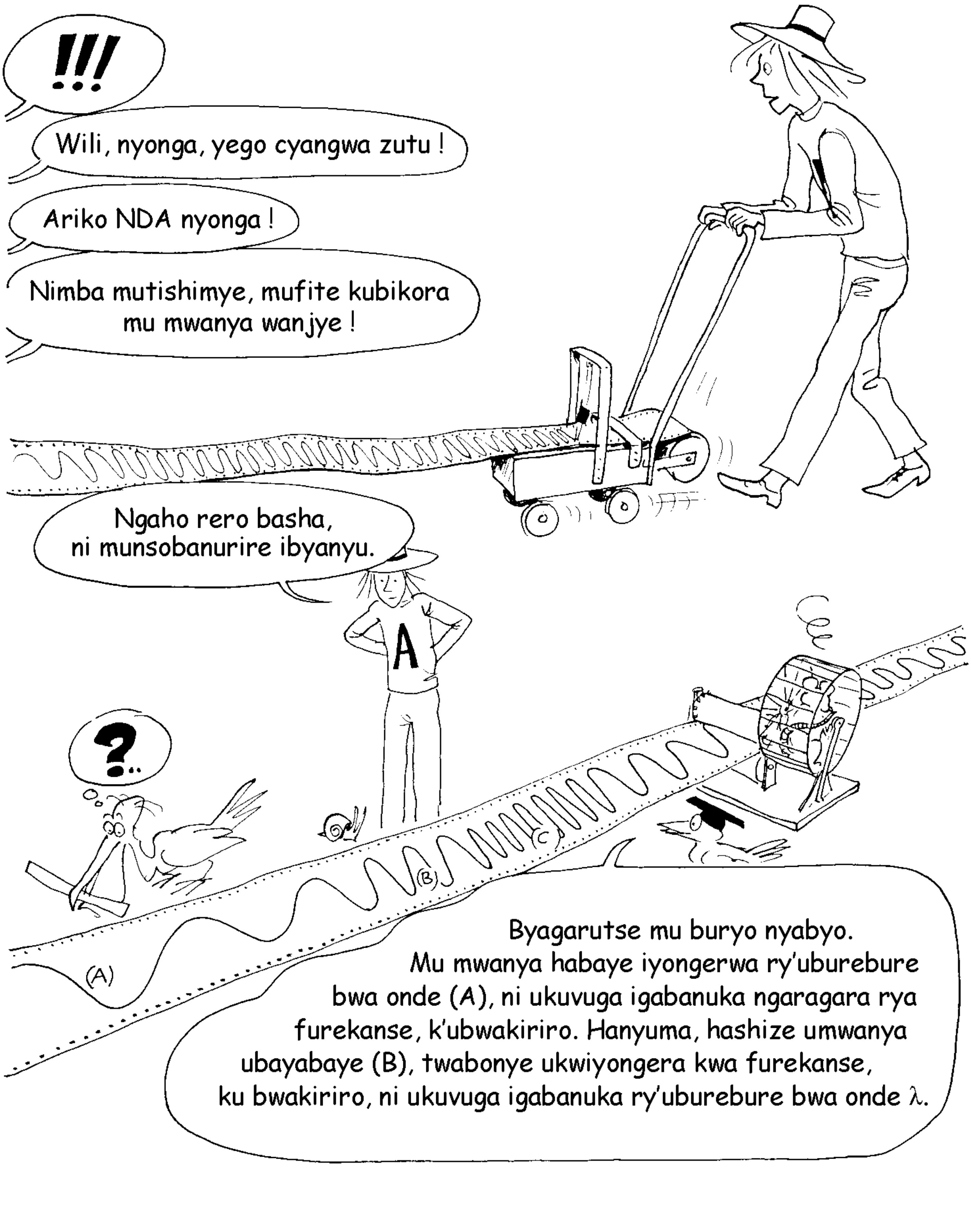

Kugirango hasubizwe ikibazo cya Lewo, tube turetse iyo Iniveri y'umusambi noneho tugaruke mu gihe cy'ubu.
UBUNGUBU
ZERO
Hamwe n'ibikurikira byose ? Ikorwa ry'amagaragisi, ry'inyenyeri ? ... tubirekyere iruhande ?...
Oya, ibyo byose bizavugwa mu gitabo cyitwa AMAZUBA IGIHUMBI.

INYEREKANAGIKORWA YA DOPELERI



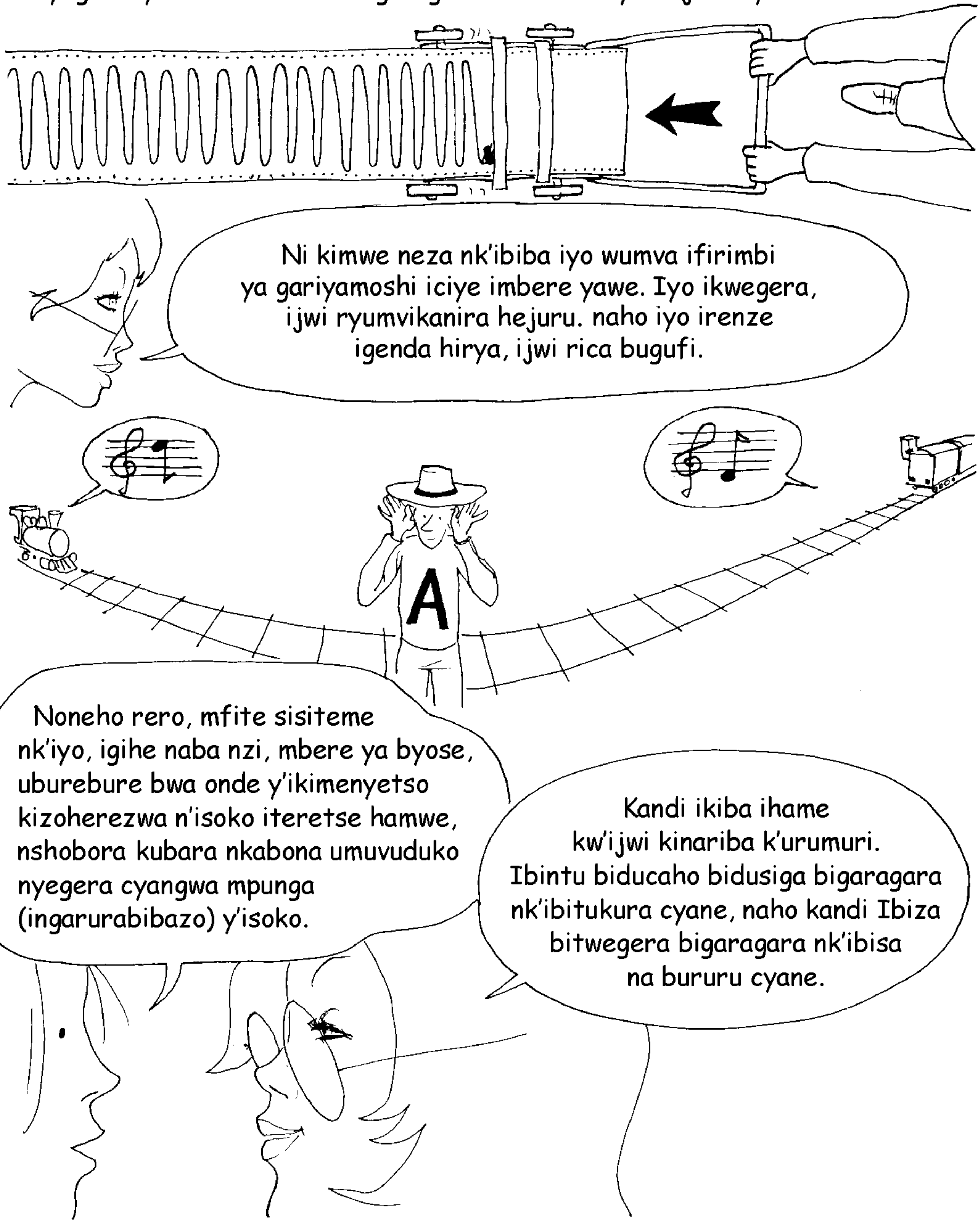
Aha, ndabyemeye. Nanjye nshobora gupima uburebure bwa onde k'ubwakiriro.
λ
Hari imyicundo N kw'isogonda. Rero buri njyenda-ngaruka ya pandile ikorwa muri kimwe mu bice N by'isegonda: uwo ni PERIYODE ya onde. Muri icyo gihe, bande iricuma urugendo rungana na λ = c /N (uburebure bwa onde).
λ
λ
Ferekanse zo hasi, periyode ndende, uburebure bwa onde bunini. Ferekanse ndende, periyode ngufi, uburebure bwa onde buto.
Bituma abantu bohererezanya ubutumwa.
Itumanaho ni ingirakamaro.
Byiza. Ngiye kugerageza iyoherezabutumwa k Urugendo rurerure.
Mwiteguye ?


Umuvuduko c
Twagiye!...
Wili nyonga, ni byiza...
He !!! uriho urakora iki ? urahindura ferekanse ?
Oya, na busa pe.
Aho, byagarutse mu buryo byiza...
Wili, urizera ko unyonga mu buryo butanga umuvuduko umwe ?
Rwose pe !
Umuntu yagirango mu mwanya umwe uranyonga n'ingoga...
Hari ikintu kiba iyo nigijeyo apareye. Ngiye kuyisubiza mu kicaro cya yo.
Imikorere y'amageza ijyana imicungire y'igitsure cya cyane.


!!!
Wili, nyonga, yego cyangwa zutu !
Ariko NDA nyonga !
Nimba mutishimye, mufite kubikora mu mwanya wanjye !
Ngaho rero basha, ni munsobanurire ibyanyu.
A
?..
(A)
(B)
(C)
Byagarutse mu buryo nyabyo. Mu mwanya habaye iyongerwa ry'uburebure bwa onde (A), ni ukuvuga igabanuka ngaragara rya furekanse, k'ubwakiriro. Hanyuma, hashize umwanya ubayabaye (B), twabonye ukwiyongera kwa furekanse, ku bwakiriro, ni ukuvuga igabanuka ry'uburebure bwa onde λ.

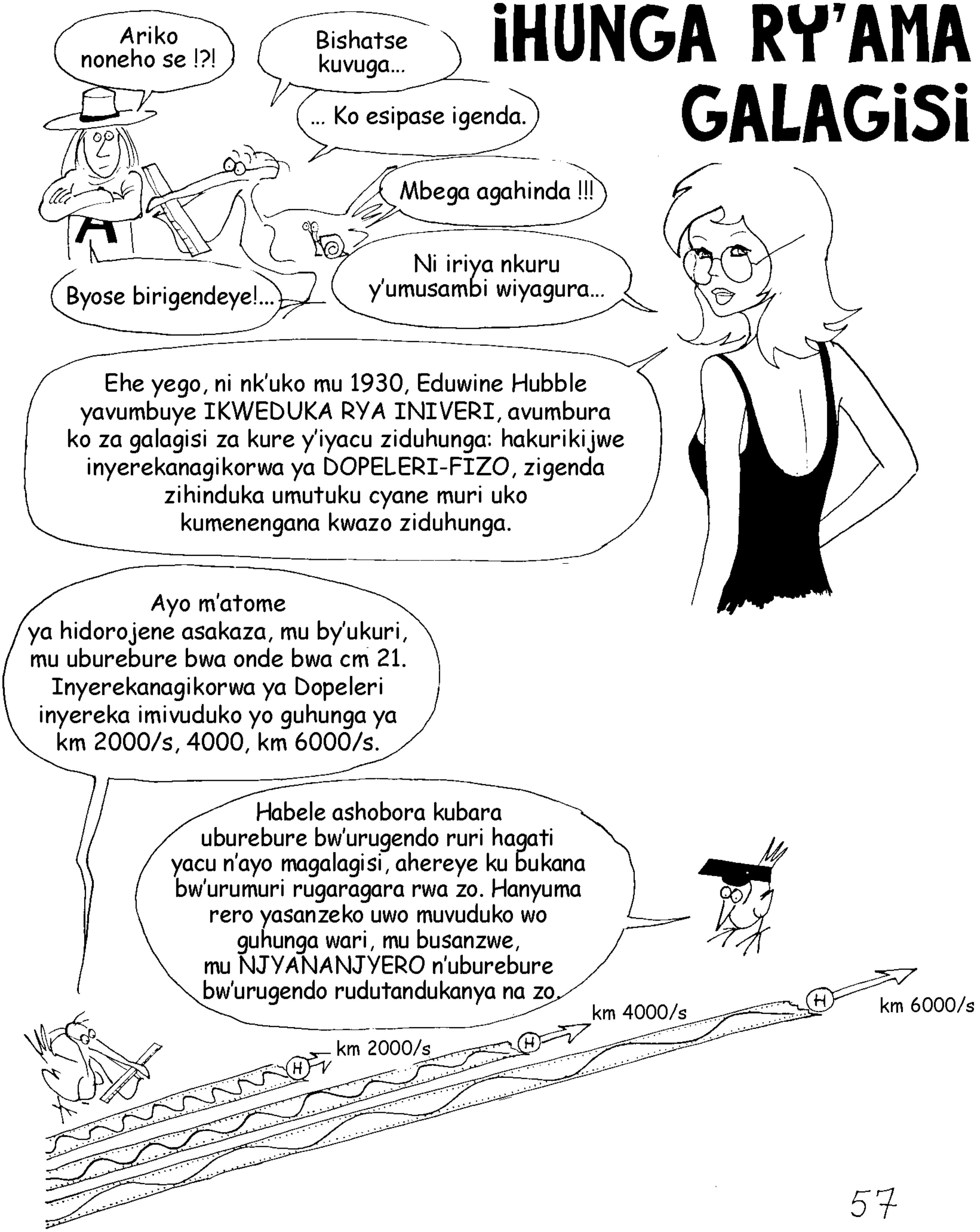
He, nshobora guhagarara ?
Yego, Wili, hagarara.
Wili avuga ko yagiye anyonga k'umuvuduko umwe.
Yenda ni urupapuro rwikweduye cyangwa rwiyegeranije ?
Oya, Anselimi, ni inyerekanagikorwa ya Dopelere-Fizo.
i... iki ?!?
Iyo unyeganyije ikigare, ibyo bihindura furekanse ngaragara.
Iyo ikigare kigiye hirya, sinizoyidale irikwedura na furekanse ikagaragara ko ari ntoya cyane.

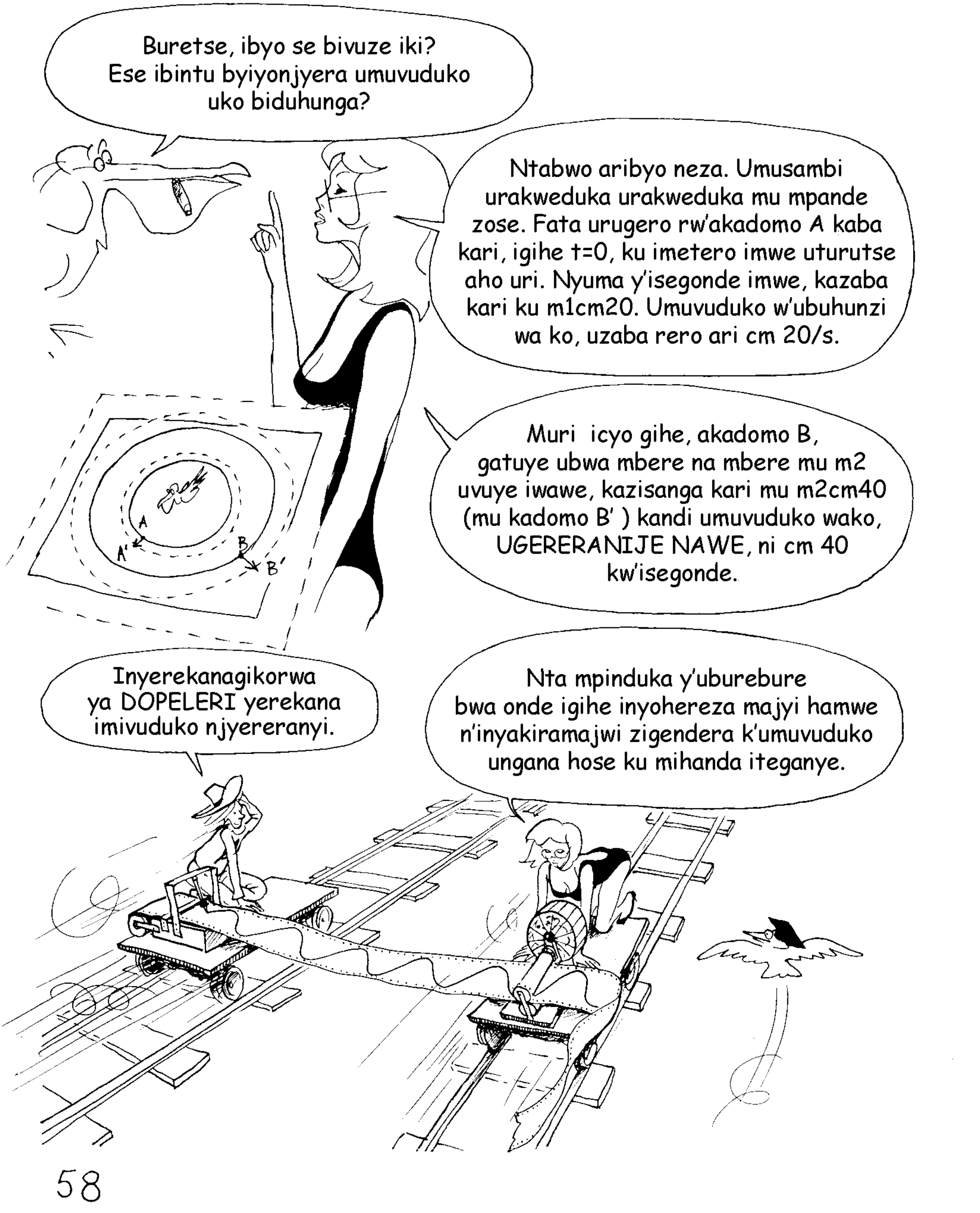
Iyo ikigare kyigize hino, kyikicuma kuri bande, sinuzoyide iritsindagira, ikiyegeranya na furekanse ikagaragara nk'aho ari iyo hejuru cyane.



Byiza, tugaruke kuri ya mageza yacu y'iyohereza butumwa ku hantu h'intera.
Wili, mu mwanya wa we.
Yahinduye furekanse !?
Cyangwa rero yigiye hirya...
Biratangiye nko mu kanya gashize.
Yego, ni byo ! Agomba n'ubu kwigira hirya.
Oya ariko, mwa bitindi by'ibigoryi, ntaho nagiye kuko ndi HANO!...
Na osiyateri yagumye hariya.

iHUNGA RY'AMA GALAGiSi




Buretse, ibyo se bivuze iki?
Ese ibintu byiyonjyera umuvuduko uko biduhunga?
Ntabwo aribyo neza. Umusambi urakweduka urakweduka mu mpande zose. Fata urugero rw'akadomo A kaba kari, igihe t=0, ku imetero imwe uturutse aho uri. Nyuma y'isegonde imwe, kazaba kari ku m1cm20. Umuvuduko w'ubuhunzi wa ko, uzaba rero ari cm 20/s.
A
A'
B
B'
Muri icyo gihe, akadomo B, gatuye ubwa mbere na mbere mu m2 uvuye iwawe, kazisanga kari mu m2cm40 (mu kadomo B') kandi umuvuduko wako, UGERERANIJE NAWE, ni cm 40 kw'isegonde.
Inyerekanagikorwa ya DOPELERI yerekana imivuduko njyereranyi.
Nta mpinduka y'uburebure bwa onde igihe inyohereza majyi hamwe n'inyakiramajwi zigendera k'umuvuduko ungana hose ku mihanda iteganye.

INDIBA Y'IJURU IRAKONJE

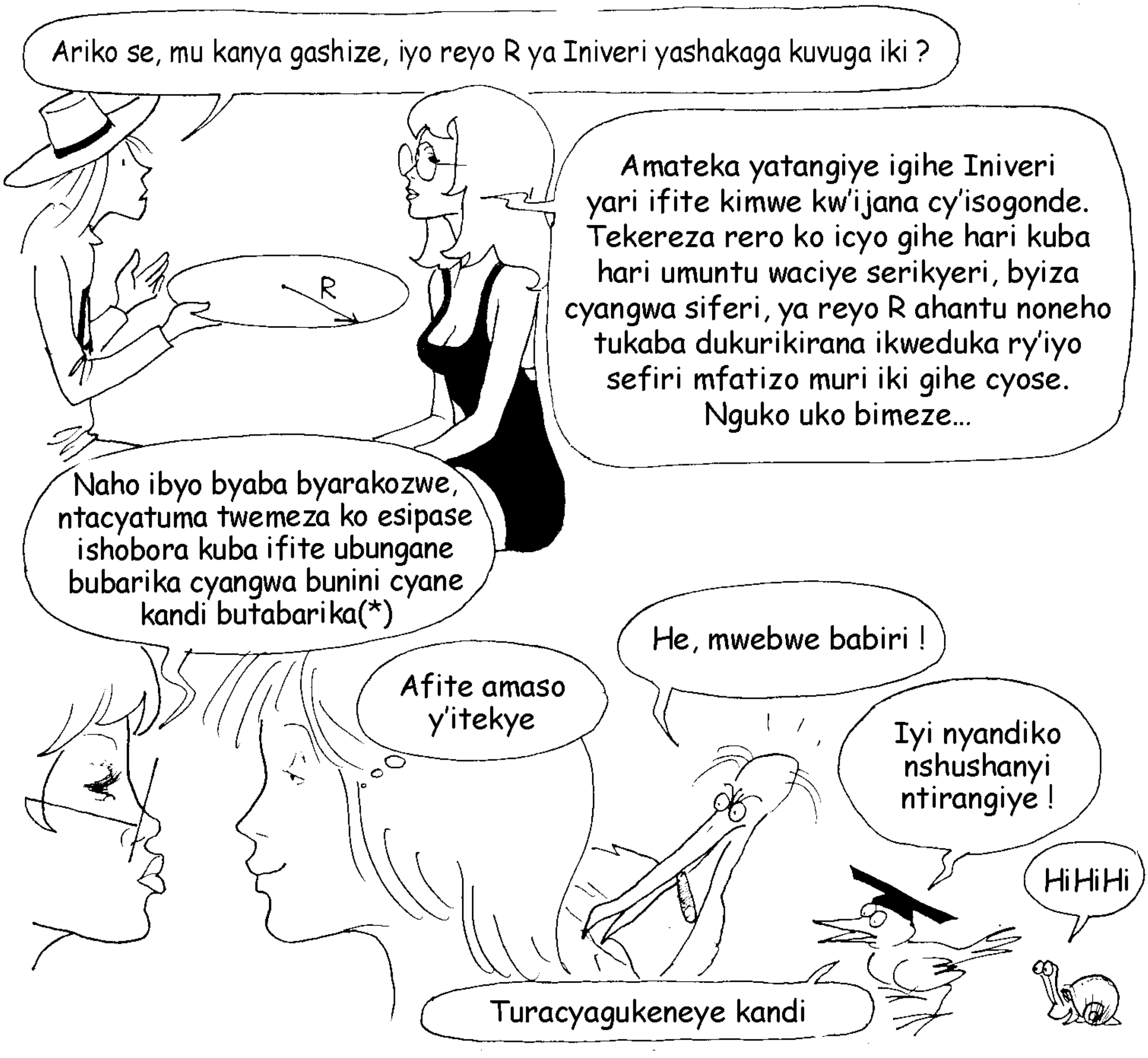
Mu kanya gashize, twari twabonye ko I fotoni imwe gusa kuri miliyaridi ariyo yashoboye kwihindura muri matsiyeri.
Naho se muri ndwanyamatsiyeri!
Hakabaye rero harasigaye inganamubare nini y'ayo mafotoni y'ibanze, hafi ya 500 kuri sentimetero cyibe (na netirinosi zingana gurtyo, zitoroshye na busa kuvumbura aho ziri).
Uburebure bwa onde bwazo bwagombye kuba bureshya na milimetero eshanu. Ibi bijyana n'igipimo cy'ubushyuhe bw'umurasire T_R bungana na dogere ndashyikirwa eshatu (-270°C)
Izo fotoni, z'ingufu nkye cyane, Peniziyasi na Wilisoni bazibonye mu 1964. Ni ryo vu nyaryo BIG BANG yasize; ni ikimenyetso kigaragara cy'uwo mucezo munini nyakosimosi.
Ahaa !!!
Nguko rero...

IRENGERO RYA KOSIMOSI

(*) reba IBINTU BYOSE BIFITANYE ISANO, by'umwanditsi umwe, icapiro BELINE.

Ku byerekeye ibintu bidukikije, umuvuduko nyarolativite ungana na km 300 000 /s ugerwaho kuri siferi bita IRENGERO. Ntabwo ari urubibi RY'IBINTU BIBAHO ahubwo ni urubibi ry'IBINTU DUSHOBORA KUMENYA. Iniveri dushobora kubona ishobora kuba ari agace ka iniveri nini cyane. Iryo rengero riri kuri miliyaridi cumi z'imyaka-rumuri. Magingo aya, intera ya telesikope yo kw'isi ya mbere ireba kure, PALOMARI, ingana na miliyaridi imwe y'imyaka-rumuri.

<u>Ubuyobozi.</u>



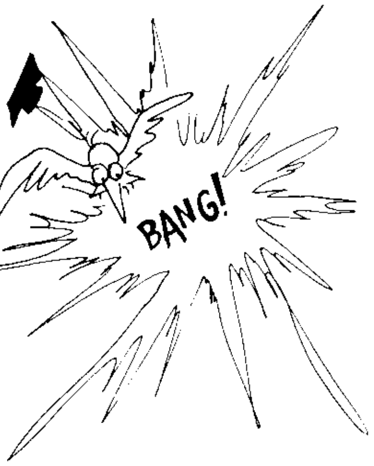
(*) kuri iyo ngingo, reba JEWOMETIRIKONI, umwanditsi ni umwe, icapiro Belini.

MODELi ZA FiRiDiMANi

None se, cyo mbwira, Iniveri yacu yari gushobora.... Guhombana aho guturika?
Mu nzira imwe, ni amahirwe...
Ni iki kikubwira ko igihe, cyo, kitari kugenda ... gisubira inyuma....
Tisisisi!...
Ese uriho urakora ibiki ?
S
N
S
N
Anselimi yashumitse sumaku ebyiri ku birato by'udupine munsi. Birakururana. Ariko rosoru itsindagiye igenda ishaka kubitandukanya yigizayo imwe ku ruhande rumwe n'ikindi k'urundi.
Urabibona, izi sumaku zigereranwa n'imbaraga karemanonkuruzi, nkuruzi, ziganisha hamwe. Rosoru igereranywa n'imbaraga sunika.
S
N

Ibi bitera gutekereza ko hariho ubwoko bubiri bushoboka bwa Iniveri:

Intekerezo ya mbere: ikweduka rirakomeza ububuraherezo. Igihe inyenyeri za nyuma zizazimira, hazaba ijoro rihoraho, ubukonje buhebuje, URUPFU RW'UBUSHYUHE.



Intekerezo ya kabiri: imbaraga karemanorukuruzi zigeraho zigatsinda. Nyuma y'ikweduka rinini ry'umurengera, Iniveri " izagaruka yigweho ubwayo". Imitererempagaze yose, za galagisi, inyenyeri, bizaturika. Ama atome ubwayo azakonjwakonjwa. Birtyo hazabaho Bigi Bange mu ncurikaburyo, kugezaho irindi zamuka rya Iniveri riba, iyindi ntera nshya y'ikweduka.

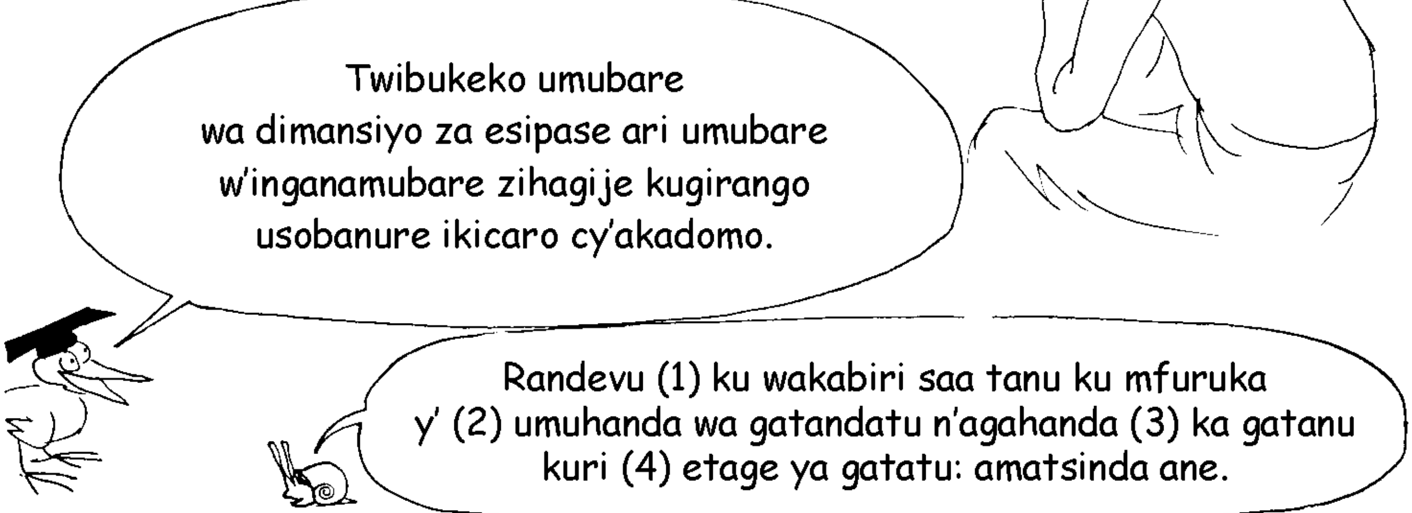
Bwana Aluberiti, nyuma y'inkiriburane z'imibare mu by'ukuri zidashoboka, wari warashoboye guhimba, mu 1917, umudeli we nyakicaro, yahise agwa mu gahinda. Firidimani yari yamurushije kuba ikirangirire. Bwana Aluberiti yahise ashyira iruhande rolativite rusange igihe cy'imyaka mwinshi.

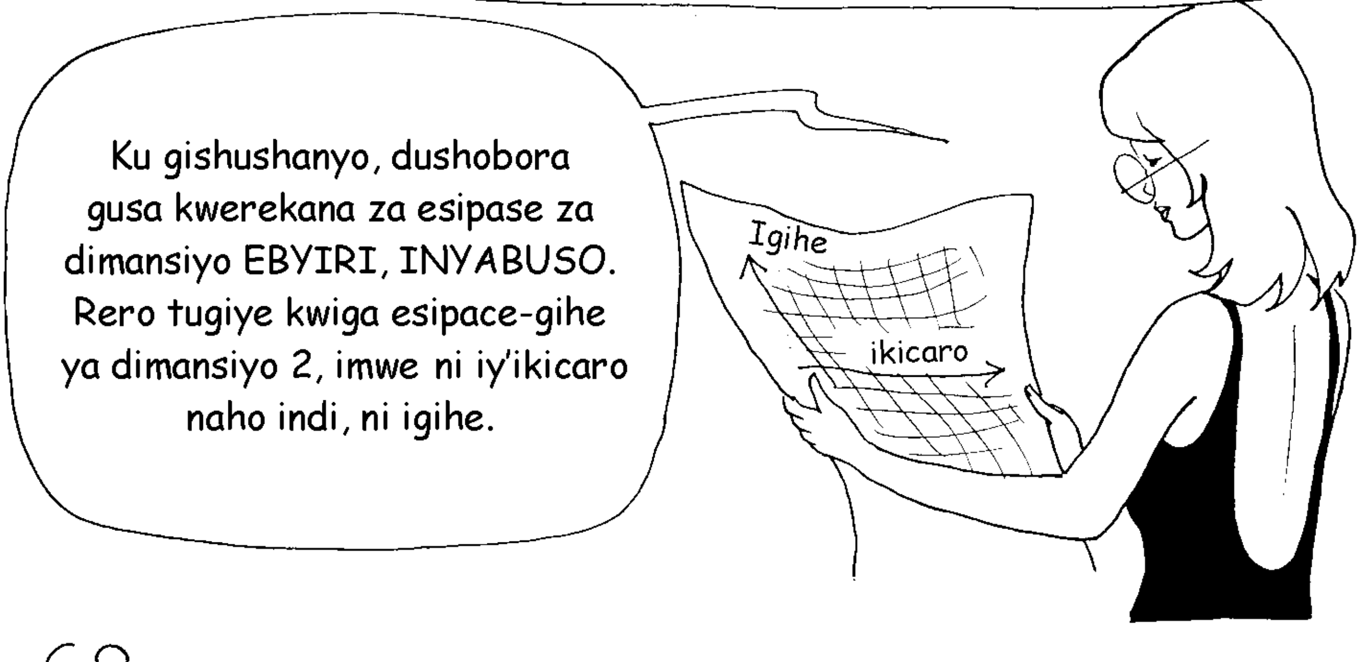
Dukurikije ama modeli ya Firidimani, Iniveri iri mw'ikweduka ritagira iherezo nimba indemere (ya magingo aya) ya matsiyeri iri munsi ya garama 5.10-30 kuri sentimetero kyibe. Iyo Iniveri kandi yaba ifite volime, n'inkweduke nyayesipase itagira iherezo.

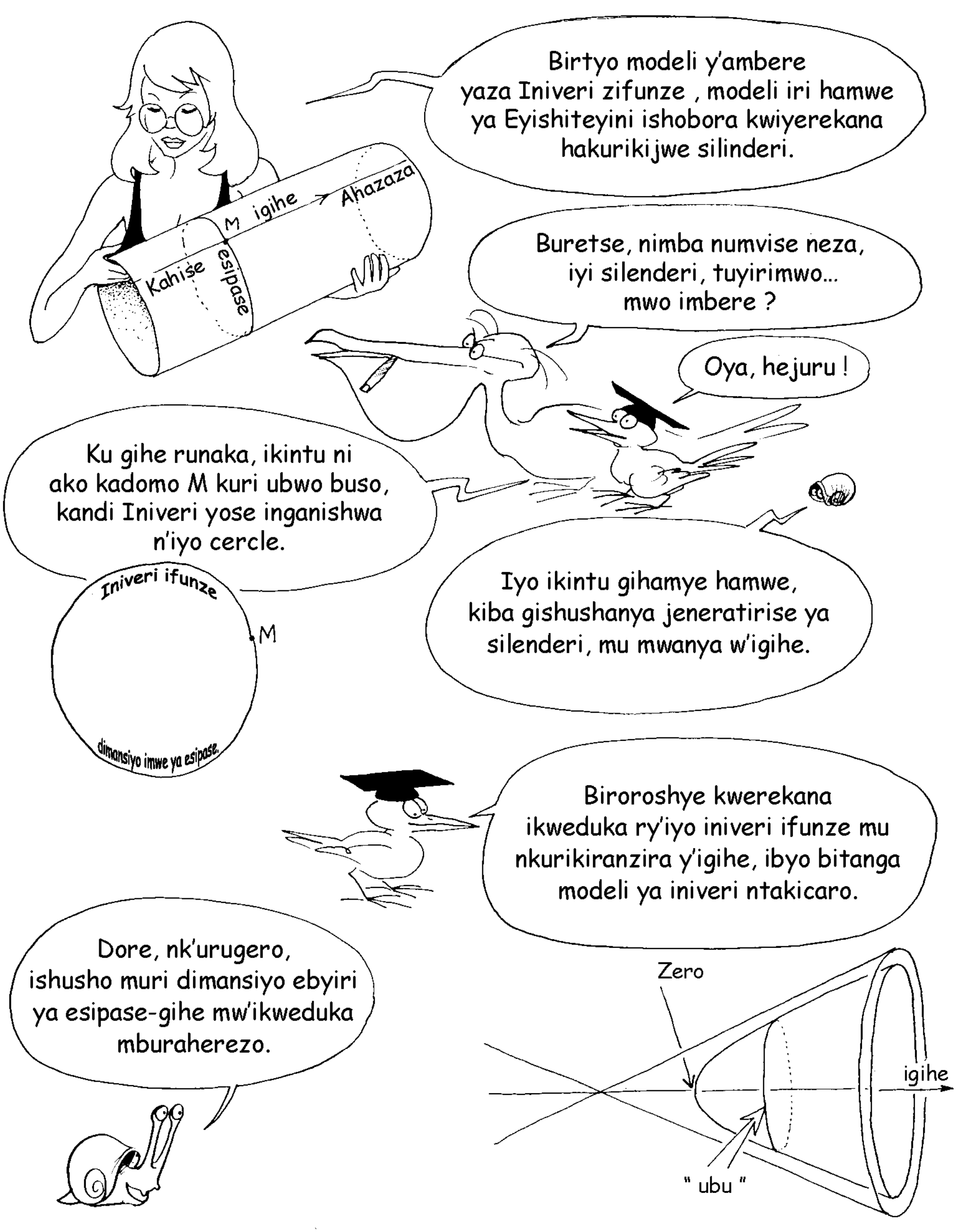
(*) Ikyibutso nyacyo cya Eyinishiteyini.

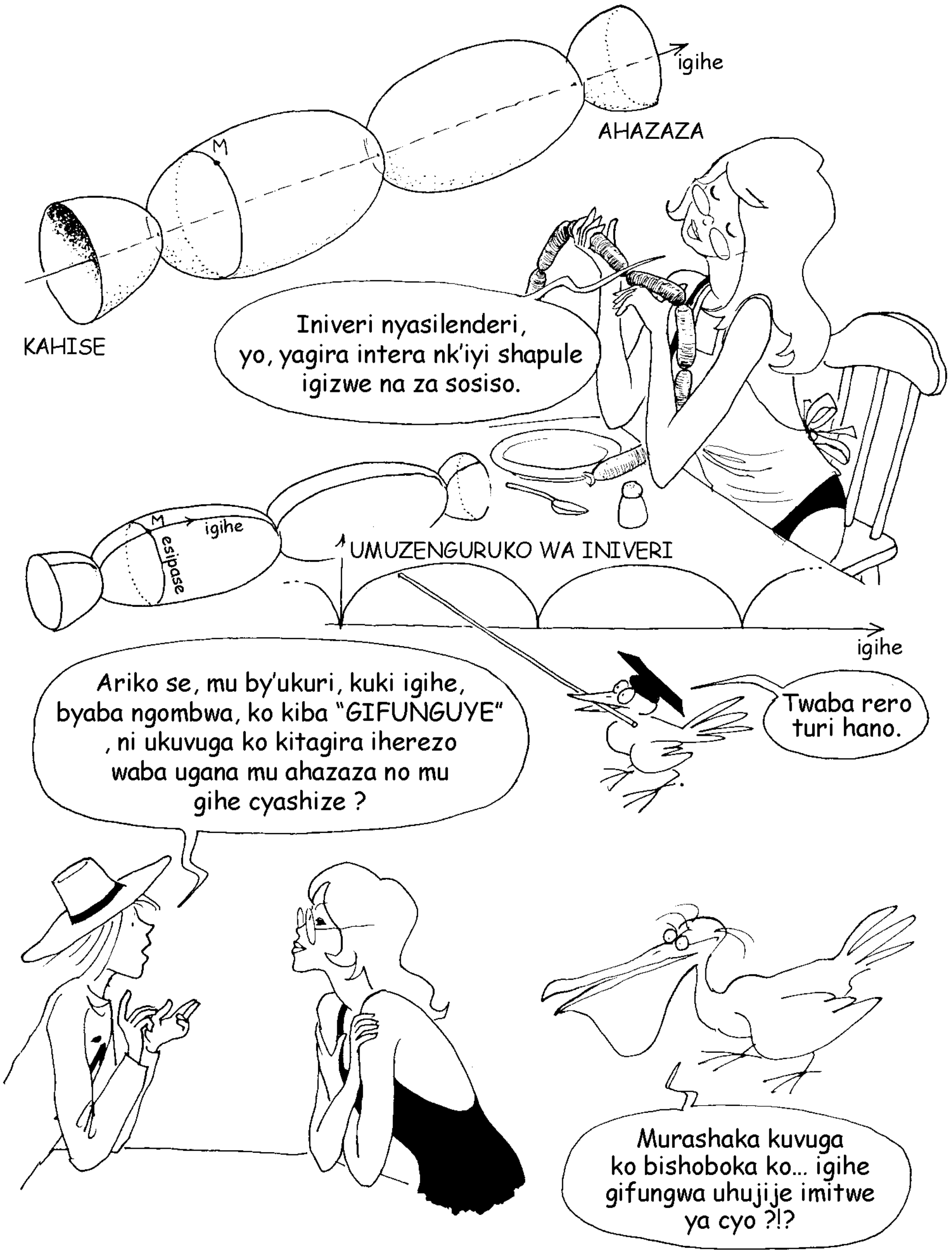
JEWOMETIRI (YA/ZA) INIVERI

Iniveri, kuri twebwe, ni indengamitererempagaze ya dimansiyo ennye, aho esipase n'igihe byivanga. Ibitekerezo byavuzwe mu mapaje twarenze bihwanye, kimwe cyose, n'inyerekanyi inyuranye y'iyo INIVERI-TSINDA ariyo ESIPASE-GIHE.






Birtyo modeli y'ambere yaza Iniveri zifunze , modeli iri hamwe ya Eyishiteyini ishobora kwiyerekana hakurikijwe silinderi.
Kahise
M
igihe
Ahazaza
esipase
Buretse, nimba numvise neza, iyi silenderi, tuyirimwo... mwo imbere ?
Oya, hejuru !
Ku gihe runaka, ikintu ni ako kadomo M kuri ubwo buso, kandi Iniveri yose inganishwa n'iyo cercle.
Iniveri ifunze
M
dimansiyo imwe ya esipase.
Iyo ikintu gihamye hamwe, kiba gishushanya jeneratirise ya silenderi, mu mwanya w'igihe.
Biroroshye kwerekana ikweduka ry'iyo iniveri ifunze mu nkurikiranzira y'igihe, ibyo bitanga modeli ya iniveri ntakicaro.
Dore, nk'urugero, ishusho muri dimansiyo ebyiri ya esipase-gihe mw'ikweduka mburaherezo.
Zero
igihe
" ubu "


igihe
AHAZAZA
M
KAHISE
Iniveri nyasilenderi, yo, yagira intera nk'iyi shapule igizwe na za sosiso.
M
igihe
esipase
UMUZENGURUKO WA INIVERI
igihe
Ariko se, mu by'ukuri, kuki igihe, byaba ngombwa, ko kiba "GIFUNGUYE" , ni ukuvuga ko kitagira iherezo waba ugana mu ahazaza no mu gihe cyashize ?
Twaba rero turi hano.
Murashaka kuvuga ko bishoboka ko... igihe gifungwa uhujije imitwe ya cyo ?!?

Nta kibazo ...
turamutse dufunze modeli
ya Eyinshiteyini duhujije
imitwe ya yo, twabona...
INGATA.
Kandi se !...
igihe
Muri iyo ESIPASE-GIHE ifunze rwose,
evenoma zimwe ziba mu rukurikirane ruhora rugaruka rusa
kwakundi nyuma y'igice cy'umwanya T ari cyo bita PERIYODE
y'iyo nteramatsiko ya iniveri .
Inyakimwe BIGI BANGE
ikicarorugendo
cy'ikweduka muherezo.
igihe
Ubu
Birashoboka ko iniveri
nsubirahoyahoze yakwizinga
igahuza imitwe.
Bihinduka ishapule ya za sosiso,
yifungiyeho ubwayo, igizwe n'isosiso imwe !
Ohu, reba Lewo !!!
Ya payutse,
byari byitezwe.

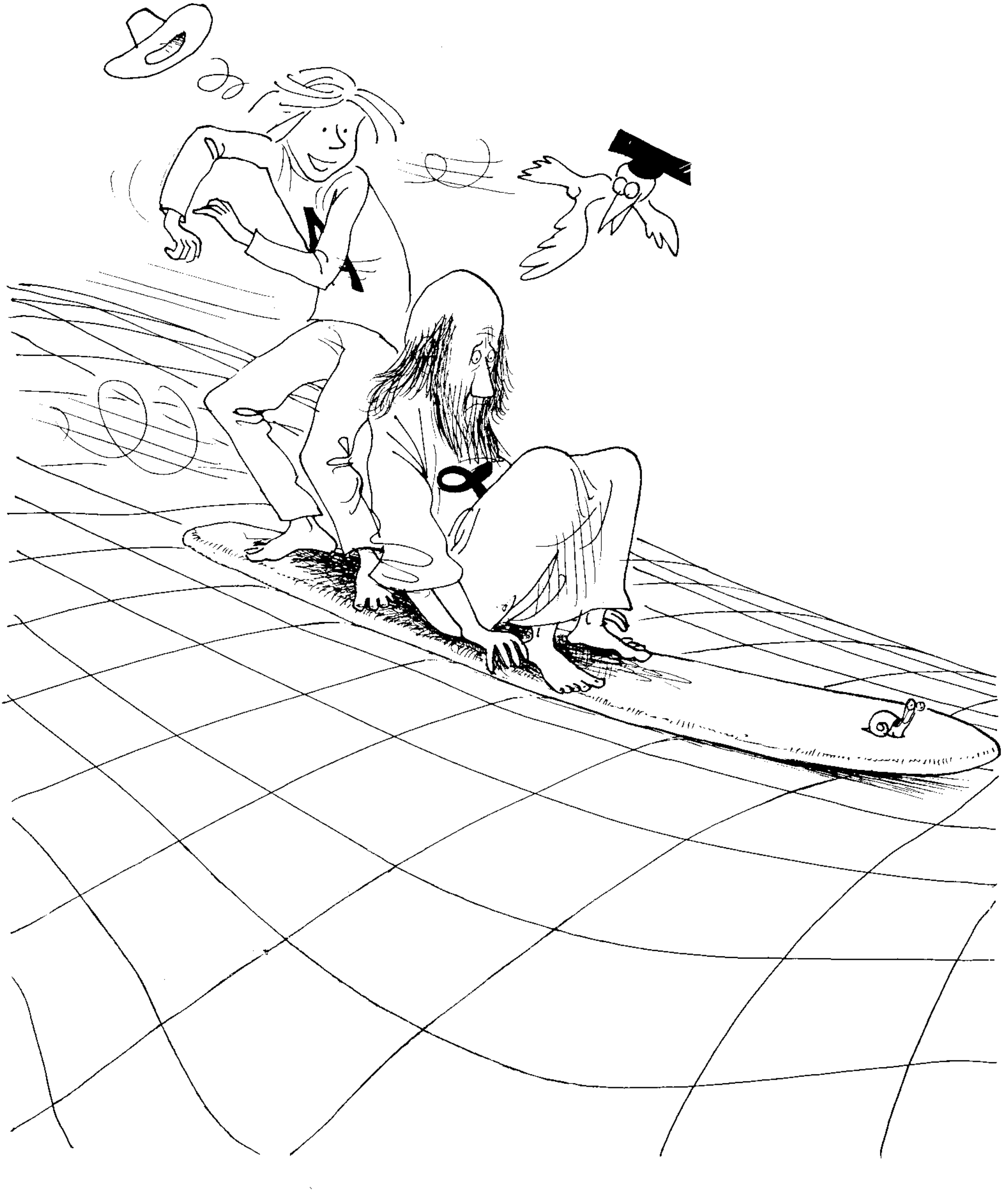
iNGANAMUSOZO

"Ariko icyo gikorwa
mpurizwaho rusangi kugirango
dusobanukirwe Iniveri icyo aricyo, ni kimwe
mu bintu mbarwa biha ikuzo ubuzima-muntu
bukarengera inkinamico yo muri iyi si, bikana
buha agaciro na gacye muri aya makuba
twiberamwo."

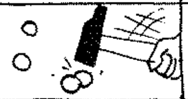
Gitefano Weyiniberige

Ibikurikira BIG BANG (iremwa ry'amagalagisi, ry'inyenyeri, n'ibindi n'ibindi...) murebe mu MAZUBA IGIHUMBI

UMUSOZO



KOSiMOSi NYAMAHANO

IGIHE	IGIPIMO CY'UBUSHYUHE	INDEMERE	FENOMENE
MBERE YA ..	$T \geq$ dogere 10^{12}		?..
1/1000 cy'i segonde	Dogere miliyalidi 300		Igikoma cy'imvangye ya za fotoni, netirinosi, ndwanyanetirinosi (fotoni yo ni yo ubwa yo ndwanyaparitikile ya yo) ya za porotoni, ya za ndwanyaporotoni, y'ama elegitoroni na ndwanya-elegitoroni (pozitoroni).
1/100 cy'isegonde	Dogere miliyalidi 100	Miliyalidi 4 za g/cm^3	Irigita-honero rya za hadoroni (porotoni, ndwanyaporotoni, netirinosi, antinetirinosi). Hazasigara imwe rukumbi kuri buri miliyalidi imwe. Ibindi byahoneye hamwe na za ndwanyahadoroni z'icyo gihe, kugirango bitange ama fotoni.
1/10 cy'i segonde	Dogere miliyaridi 30		Nta cyo gutangaza. birashyushye bikabije kuburyo nta za nuwayo z'atome zakirema.
Segonde 1	Dogere miliyaridi 10	g/cm^3 380 000	Za netirinosi " zibaho mu buzima bwazo". Zireka kugira imihurirebikorwa na matsiyeri.
Segonde 13	Dogere miliyaridi 3		Irigita-honero rya za elegitoroni- ndwanya-elegitoroni. Aho naho hazasigara, imwe kuri miliyaridi imwe.
Iminota 3	Dogere miliyali 1		Iremwa rya nikeleyoni: iremwa za nikeleyoni za Eliyomu. Irigita rya za netoroni zigenga (uburambe bw'ubuzima: ama segonde 109)
Iminota 35	Dogere miliyoni 300	~ g/cm^3	Iremwa rya nikeleyoni riba rirarangiye: 25 % ya Eliyomu, 75% ya Idorojene.
700,000 yr	Dogere 3000.		Nyuma y'ihonero rya matsiyeri na ndwanyamatsiyeri nka byose, Iniveri yabaye mu "bihe nyamurasire", aho itsinda ngufu-matsiyeri byabaye ku bwinshi mu foroma murasire. Igihe igipimo cy'ubushyuhe kimanutse kikagyera kuri dogere 3000, ama atome ntagiramashanyarazi yahise akorwa noneho za fotoni zireka imihurirebikorwa na matsiyeri: Iniveri itangira noneho "kubonerana".
Imyaka miliyoni 100	T_R = -173° C T_m = -276 °C		Kuko zitari zigishyushya na za fotoni, atome za idorojene n'iza eliyomu zitagira amashanyarazi zagiye kubona zibona igipimo cy'ubushyuhe bwa zo kiriho kiragabanuka n'ingoga. Bihita bibyara iremwa z'ama galagisi n'inyenyeri za mbere.
Imyaka miliyaridi 5			Iremwa ry'umubumbe w'isi
Imyaka miliyari 10	T_R = - 270°C	10^{-30} g/cm^3	Itunguka ry'ubuzima
Uyu munsi			Ivumburwa rya bombe atomikye....