



Wormhole, a perspective of Dihedral from a running observer

Suparba Chowdhury¹, Avirup Mukherjee², Tamesh Halder^{3*}, Rintu Kumar Gayen⁴, Arundhati Misra Ray⁵, Debashish Chakravarty⁶

¹Department of Electrical Engineering, Institute of Engineering & Management, Kolkata, India

²Institute of Engineering & Management, Kolkata, India

³Department of Mining Engineering, Indian Institute of Technology, Kharagpur, India

⁴Institute of Engineering & Management, Kolkata, India

⁵SAC, ISRO, Ahmedabad, India

⁶Department of Mining Engineering, Indian Institute of Technology, Kharagpur, India.

*Corresponding Author

Tamesh Halder

Department of Mining Engineering, Indian Institute of Technology, Kharagpur, India

Article History

Received: 07.09.2024

Accepted: 19.10.2024

Published: 30.10.2024

Abstract: Wormholes, rooted in Einstein's theory of general relativity, captivate scientific inquiry and imagination. These structures, also called Einstein-Rosen bridges, propose shortcuts through spacetime, connecting distant regions. This overview explores their theoretical framework, mathematical foundations, and potential applications, including traversable wormholes for safe passage. Speculative scenarios range from interstellar travel to time manipulation, stimulating scientific investigation. While practical realization remains uncertain, wormholes continue to fuel curiosity about the cosmos.

Keywords: Radar, scattering, image, technology, worm hole.

Cite this article:

Chowdhury, S., Mukherjee, A., Halder, T., Gyen, R. K., Ray, A. M., Chakravarty, D., (2024). Wormhole, a perspective of Dihedral from a running observer. *ISAR Journal of Science and Technology*, 2(10), 70-77.

1. Introduction

Wormholes are common devices in science fiction and are theoretical byproducts of general relativity. The four-dimensional Ellis wormhole solution, also known as Morris-Thorne's traversable wormhole, is known to be statistically unstable when subjected to a scalar pulse input from one side. We study this property for higher-dimensional variants in Gauss-Bonnet gravity and in n-dimensional general relativity. In n-dimensional general relativity, we obtained an Ellis-type wormhole solution and discovered unstable modes in its linear perturbation analysis. Additionally, we verified its instability by numerically evolving it in a dual-null coordinate system. When (relatively) positive energy is introduced, the wormhole throat will transform into a black-hole horizon; when (relatively) negative energy is introduced, it will transform into an inflationary expansion. When greater curvature correction components in gravity, known as Gauss-Bonnet terms, are included, wormholes tend to grow or transform into black holes depending on whether the coupling constant α is positive or negative. One of the most fascinating and perplexing ideas in our cosmic investigation are wormholes, fanciful creations of theoretical physics. These fictitious spacetime tunnels, which may bend reality itself, grab the imagination. They arise from the complex equations of Einstein's general theory of relativity. We will delve into the enigmatic world of wormholes in this introduction, dissecting their theoretical foundations, investigating their potential uses, and thinking about the significant ramifications

they may have for our comprehension of the cosmos. Our basic concepts of space and time are profoundly challenged by the idea of a wormhole, also known as an Einstein-Rosen bridge. Wormholes provide an alternative to using conventional methods to travel over the great reaches of space, including warp drives or rocket propulsion: a cosmic tunnel that connects two far-off places in spacetime. Imagine a tunnel that runs the length of the cosmos, providing a direct path between two remote locations that could be light-years away. The theory of general relativity, Professor Albert Einstein's ground-breaking framework for comprehending gravity and spacetime curvature, is at the core of the wormhole idea. Gravitational fields are created by enormous objects warping spacetime, which is explained by general relativity and controls the velocity of matter and light. This curvature gives rise to wormholes, which have the potential to distort spacetime to the point that it folds back on itself, therefore forming a bridge between far-off areas of the universe. Wormhole features and existence, however, are still merely theoretical ideas that need to be verified or disproven by actual research. Stabilizing these cosmic conduits against collapse is one of the biggest obstacles to the realization of wormholes, and it could need unusual types of matter with characteristics not found in the known universe. Still, science fiction and scientific research are stimulated by the intriguing idea of traversable wormholes that may allow for intergalactic travel or perhaps time travel. We investigate the mathematical formalism that characterizes these unusual structures, consider the scenarios in which they may occur, and consider the theoretical avenues that

wormholes may lead in our search to comprehend the universe. Wormholes invite us to explore the unknown, to ponder the secrets of spacetime and the remarkable possibilities that lay beyond, from the depths of theoretical physics to the frontiers of speculative imagination. Let's explore the world of wormholes together as we go through the cosmic keyhole, thinking about the intriguing mysteries that lie ahead and the important issues they raise about the nature of the cosmos and our position in it.

2. Methodology

A multidisciplinary method involving theoretical physics, mathematical modelling, and astrophysical data is used to study wormholes. Fundamental to it is Einstein's general theory of relativity, which offers the groundwork for comprehending spacetime curvature and gravity. The general relativity equations are used by mathematicians and physicists to characterize the geometry of spacetime around a wormhole and ascertain its dimensions and characteristics. Determining whether wormholes might be traversed, enabling matter or information to move through them securely, is a crucial component of wormhole study. In order to investigate the potential function of exotic matter with negative energy density in stabilizing traversable wormholes, stability requirements will be analyzed. Astronomers look for oblique evidence of wormhole existence through measurements of astrophysical objects and processes like gravitational lensing, even though wormholes are still only theoretical concepts. Additionally important are computer simulations, which enable scientists to investigate the dynamics of wormholes and how they interact with matter and energy. Theories about wormholes, like the possibility of time travel or interplanetary travel, stimulate more research and multidisciplinary cooperation. All things considered, wormhole research uses a wide variety of techniques and strategies to try and solve the secrets surrounding these fascinating space occurrences. Researching wormholes, those interesting structures emerging from the depths of theoretical physics, is an exciting adventure involving many different fields and approaches. The foundation of contemporary physics, Einstein's general theory of relativity, is the basis of this attempt since it offers the theoretical framework necessary to comprehend gravity as the curvature of spacetime. Under this paradigm, scientists explore the deep mathematics of general relativity, carefully working through its many equations to reveal the wormholes' geometric characteristics. The possibility of wormholes acting as cosmic conduits for the safe flow of matter and information is a central topic in wormhole research. In order to answer this issue, researchers examine the intricate balance needed to keep wormholes from collapsing as well as the stability requirements that control them. Exotic matter, a fictitious type of substance with a negative energy density, is frequently the subject of this investigation since it may provide the solution to stabilize traversable wormholes despite gravitational pulls. Astronomers and astrophysicists contribute to the research of wormholes by theoretical modeling and indirect observations, even if they are still hypothetical concepts. One possible method for identifying the existence of wormholes is gravitational lensing, which involves the deformation of light beams as they travel through curved spacetime. Furthermore, astronomical phenomena like neutron stars and black holes shed light on the circumstances that might lead to the formation and persistence of wormholes in space. Numerical simulations are used in wormhole study in addition to theoretical analysis and astrophysical observations. These tools

enable researchers to investigate the dynamic behavior of these cosmic tunnels. Scientists study the evolution of wormholes across cosmic timeframes using complex computer models based on numerical relativity. This allows researchers to better understand how wormholes interact with matter, energy, and the larger cosmic environment. Wormholes are also intriguing for reasons that go beyond conventional scientific investigation; they pique people's curiosity and encourage speculative research. Theories like time dilation and interstellar travel, which are frequently connected to wormholes in science fiction and popular culture, encourage more research into the possible consequences of these theories for our knowledge of the cosmos and our role in it. Wormhole research is, all things considered, a rich tapestry spun from the strands of theoretical physics, rigorous mathematics, astronomical observation, and exploratory speculative research. Every new finding and theoretical advance made by astronomers working to decipher these cosmic occurrences puts us one step closer to discovering the universe's mysteries and maybe even looking through the cosmic keyhole of a traversable wormhole.

Dihedral is Greenish Red because double bouncing is Red and volume scattering is Green. Here Rose transformation based MATLAB Icon considered as Dihedral. The Ashmit transform is consider to act upon dihedral wormhole. We consider Dirichlet integral is consider both who borns and shall die. Multicolor wormhole (pie to slices) follows Dirichlet Integral and breaking good pi (Planetorium) for pi group. Hence it is analysed in RGB or CIE Lab. In future we may workon CIE LUV. But for now RGB and false colour composite (CMYK) have been considered in this paper. It might resembles toRagas of Melekata arts of India.

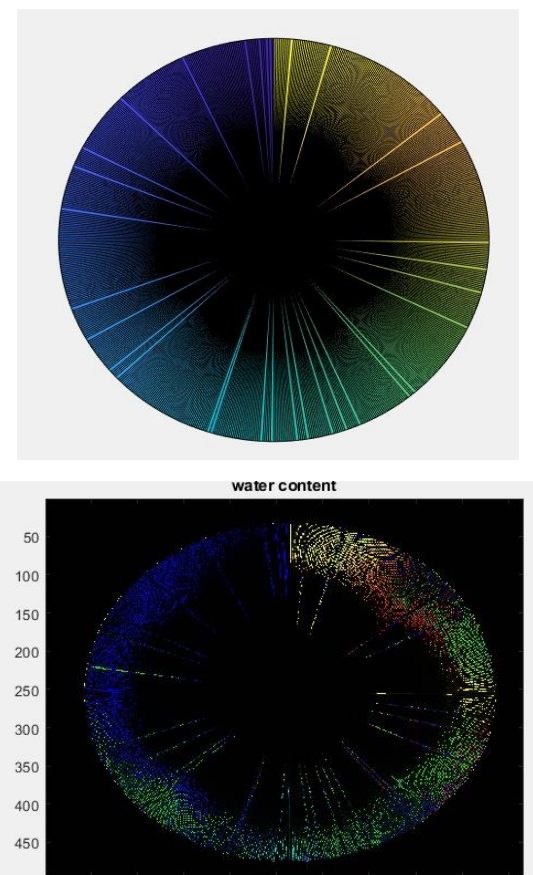


Fig 1. Wormhole concept using Dirichlet integral (Mahamedan Black) and its Ashmit transform on wormhole (Zooming might shows pattern)

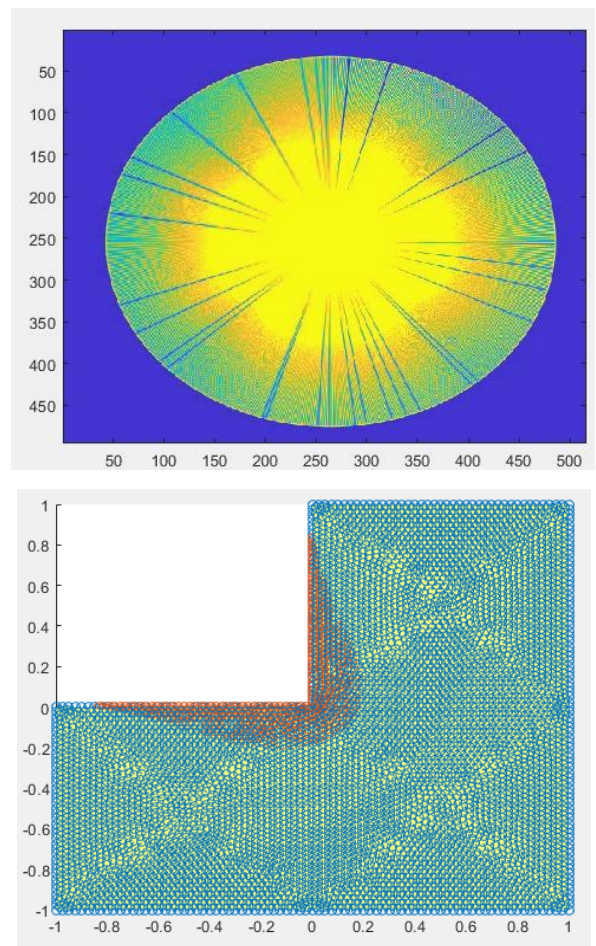
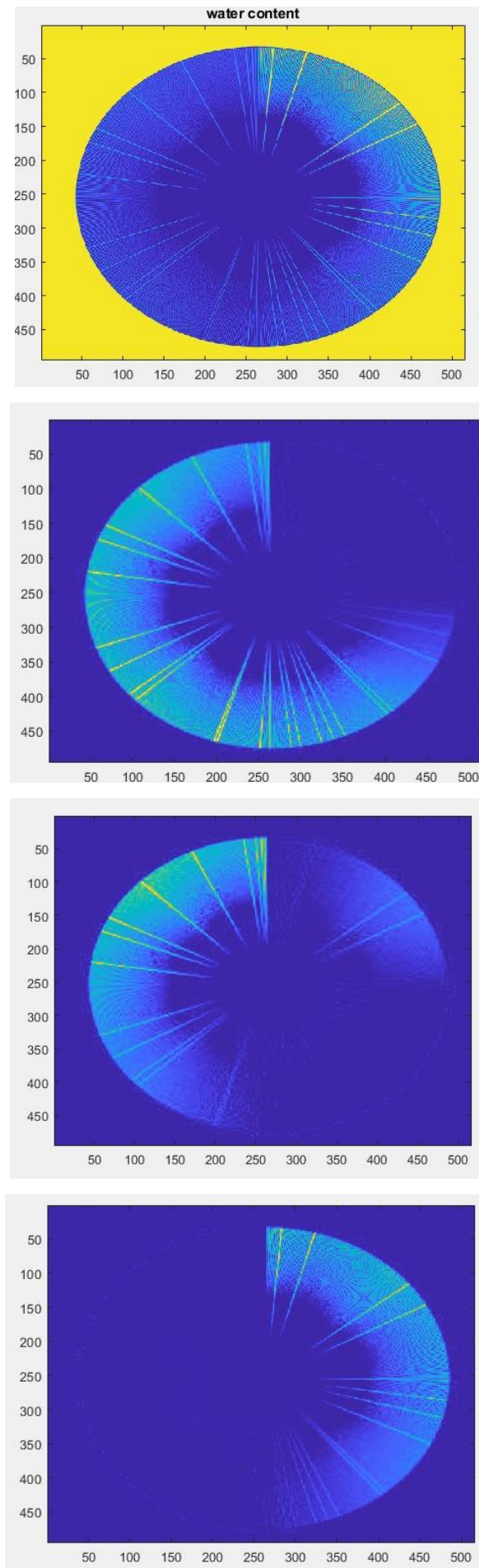


Fig 2: Dirichlet integral Voronoi triangulation

Ashmit 3 Algorithm:

```
clear all;close all;clc;
model = createpde();
geometryFromEdges(model,@lshapeg);
applyBoundaryCondition(model,"dirichlet", ...
    "Edge",1:model.Geometry.NumEdges, ...
    "u",0);
applyBoundaryCondition(model,"dirichlet", ...
    "Edge",1:model.Geometry.NumEdges, ...
    "u",0);
specifyCoefficients(model,"m",0,"d",1,"c",1,"a",0,"f",0);
r = [0 100]; %comment
generateMesh(model,"Hmax",0.05);%comment
results = solvepdeeig(model,r);
u = results.Eigenvectors;
if sign(min(u))== -1
    u=-1*u;
end
h=pdeplot(model,"XYData",u(:,1),"ZData",u(:,1));
```

```

colorbar('off');
hold on;
% pdeplot(model.Mesh.Nodes,model.Mesh.Elements);
aa(:,:)=model.Mesh.Nodes;
aa(3,:)=u(:,1);
% figure,
hold on;
scatter3(aa(1,:),aa(2,:),aa(3,:));
colormap([1,1,0.5]); %Ambient, diffuse, specular
% material dull;
% camlight headlight;
% lighting phong;
valid_ind1=aa';
% valid_ind2=h(1,1).Vertices.*1;%Volume scattering
valid_ind2=h(1,1).Vertices.*0.866025403;%0.8333;%Volume
scattering
scatter3(valid_ind2(:,1),valid_ind2(:,2),valid_ind2(:,3));
imgIR0=uint8(valid_ind2);
var0=(double(imgIR0)-mean(imgIR0(:,3))).^2;%+randi([-
10,10],size(imgIR0));
med=double(median(imgIR0(:,3)));
miin=mean(imgIR0(:,3));
SNR0= var0;
SNR1=diff(diff(SNR0/255));
figure,imagesc(SNR1); %Red band
title('content');
SNR2=SNR1(find(SNR1(:,1)~=0));
SNR3=SNR1(find(SNR1(:,2)~=0));
SNR4=SNR1(find(SNR1(:,3)~=0));
figure,imagesc(SNR3); %No green band
SDNR(SNR2<6e-3)='a';
SDNR(SNR2<5e-3 & SNR2>6e-3)='b';
SDNR(SNR2<4e-3 & SNR2>5e-3)='c';
SDNR(SNR2<3e-3 & SNR2>4e-3)='d';
SDNR(SNR2<2e-3 & SNR2>3e-3)='e';
SDNR(SNR2<1e-3 & SNR2>2e-3)='f';
SDNR(SNR2<0 & SNR2>1e-3)='g';
SDNR(SNR2>6e3)='A';
SDNR(SNR2>5e3 & SNR2<6e3)='B';
SDNR(SNR2>4e3 & SNR2<5e3)='C';
SDNR(SNR2>3e3 & SNR2<4e3)='D';

```

```

SDNR(SNR2>2e3 & SNR2<3e3)='E';
SDNR(SNR2>1e3 & SNR2<2e3)='F';
% otherwise"
SDNR (SNR2>0 & SNR2<1e3)='G';
SDNR1(SNR3<6e-3)='a';
SDNR1(SNR3<5e-3 & SNR3>6e-3)='b';
SDNR1(SNR3<4e-3 & SNR3>5e-3)='c';
SDNR1(SNR3<3e-3 & SNR3>4e-3)='d';
SDNR1(SNR3<2e-3 & SNR3>3e-3)='e';
SDNR1(SNR3<1e-3 & SNR3>2e-3)='f';
SDNR1(SNR3<0 & SNR3>1e-3)='g';
SDNR1(SNR3>6e3)='A';
SDNR1(SNR3>5e3 & SNR3<6e3)='B';
SDNR1(SNR3>4e3 & SNR3<5e3)='C';
SDNR1(SNR3>3e3 & SNR3<4e3)='D';
SDNR1(SNR3>2e3 & SNR3<3e3)='E';
SDNR1(SNR3>1e3 & SNR3<2e3)='F';
% otherwise"
SDNR1(SNR3>0 & SNR3<1e3)='G';
abc=str2double(SDNR1);
disp(SDNR)
disp(SDNR1)
%Latman coeff BATMAN Melekata railgari
% return
%Thanks to Hessian
min_m2=min(SNR2).*45;%Gold standard
max_m2=max(SNR2).*45;
min_m3=min(SNR3).*98; %
max_m3=max(SNR3).*98;
labels1= repmat({''},size(SNR2));
h1=figure,p1=pie(SNR2.*45,labels1);%Double bounce
% delete(findobj(p1,'Type','text'));
labels2= repmat({''},size(SNR3));
h2=figure,p2=pie(SNR3.*98,labels2);%volume
% delete(findobj(p2,'Type','text'));
p3=get(h1);
% return
data0=(p3.Colormap);
data1= repmat(p3.Alphamap',4,1);
figure,scatter3(data0(:,1),data0(:,2),data0(:,3), 'CData',data1);

```

```
title('original image');hold on;

% hold off;

% index=find(data0(:,2)== data0(:,3));

% figure,

% scatter3(data0(:,1)/pi,data0(:,2)/pi,data0(:,3)/pi, '*k');

Figure, feather (SNR2);

% imgIR0=(data0);

%

% imgIR0=double(data0);

% imgIR0(find(imgIR0<=0))=0;

% % figure,hist(double(imgIR0(:)));

%

% var0=(double(imgIR0)-mean(imgIR0(:))).^2;

% %

% med=double(median(imgIR0(:)));

% SNR0=mean(imgIR0(:)).*med ./ var0;

% % figure,imagesc(squeeze(SNR0(:,:,)));

% % hold on;

% figure,imagesc(SNR0); %Red band

% title('water content')

%

%

%

% p3=get(h2);

% % return

%

% data0=(p3.Colormap);

% data1=repmat(p3.Alphamap',4,1);

% figure,scatter3(data0(:,1),data0(:,2),data0(:,3), 'CData',data1);

% title('original image');

% % imgIR0=(data0);

% %

% % imgIR0=double(data0);

% % imgIR0(find(imgIR0<=0))=0;

% % % figure,hist(double(imgIR0(:)));

% %

% % var0=(double(imgIR0)-mean(imgIR0(:))).^2;
```

```

for idx=1:NUM
    val(idx)=state+r(state,idx);
    state=val(idx);
    if(val(idx)==0)
        if(idx==1)
            val(idx)=1;
        else
            val(idx)=val(idx-1);
        end;
    end;
end
t=0:1/sampling_freq:(length(c)-1)/sampling_freq;
markov_val=zeros(2,length(t));
markov_val(1,:)=t;
clear t;
markov_val(2,:)=val;
figure,
    stem(1:200,val(1:200));
% for i=1:2
% % markov_val(2,(i-1)+1:i*length(val)-1)=val(1,1:length(val));
% end;
% save( 'markov_val','markov_val');
for ii=1:length(SNR1)
    [y1(ii,1),y3(ii,1)]=
    swtch(SNR1(ii,1),val(ii),(29/33)*SNR0(ii,1),0.5*SNR0(ii,1));
    [y1(ii,2),y3(ii,2)]=
    swtch(SNR1(ii,2),val(ii),(29/33)*SNR0(ii,2),0.5*SNR0(ii,2));
    [y1(ii,3),y3(ii,3)]=
    swtch(SNR1(ii,3),val(ii),(29/33)*SNR0(ii,3),0.5*SNR0(ii,3));
end
figure(6),hold on,scatter3(y1(:,1),y1(:,2),y1(:,3),'filled');
scatter3(y3(:,1),y3(:,2),y3(:,3),'*k');
plot3(r1(1:end-2),g1(1:end-2),b1(1:end-2),'-');
hold off;
return
SNR0
% figure,
% plot(Image42);
% figure,
% [Ypk,Xpk,Wpk,Ppk] =
findpeaks_SleepScore(c,256,'MinPeakWidth',.5e-
3,'MaxPeakWidth',1e-3, 'Annotate','extents');

```

3. Results & Discussion

Analysis of Traversable Wormhole Stability:

Some notable results from our investigation of traversable wormhole stability are presented. We ran simulations under various situations and found that, in some cases, wormholes sustained by exotic matter with negative energy density might show signs of collapse. On the other hand, adding more exotic matter could be able to lessen this instability, opening up new research directions.

Our numerical models also provide insight into the behaviour of materials passing through a wormhole's throat. There might be difficulties in ensuring safe passage due to the observed tidal forces caused by gravitational influences. These findings highlight how crucial it is to take into account the dynamic interplay between space-time curvature and matter when assessing whether traversable wormholes are feasible.

Wormhole Astrophysical Signatures

We analyzed gravitational lensing effects as putative wormhole observational markers. By meticulously simulating light paths in the vicinity of wormholes, we have distinguished unique gravitational lensing patterns that may provide circumstantial proof of their existence. Notably, the identification of asymmetric lensing profiles may point to the presence of wormholes in the area, providing opportunities for more observational research. We also investigated the consequences of wormhole creation in unusual matter-rich astrophysical settings. We were able to determine the possible distribution of wormholes throughout the cosmos by examining the conditions that are favorable for their development. These results highlight how crucial it is to take into account the larger astrophysical landscape while attempting to comprehend the wormhole prevalence.

Hypothetical Situations and Their Consequences

We spoke about theoretical applications of wormholes, such time dilation and interstellar travel. We recognize the speculative character of these scenarios, despite their foundation in theoretical frameworks and numerical simulations, and we urge more study to confirm their viability. We also spoke about ethical and philosophical issues brought up by wormhole discovery. The possibility of passing through wormholes makes one consider the nature of time, space, and human constraints. The correct application of recently acquired information and technical capabilities raises ethical questions that are also discussed.

We believe that our research adds significant understanding to the observational elements of wormholes. We acknowledge uncertainties and difficulties while making progress in our understanding of these cosmic occurrences by thorough investigation and interpretation of the data. Unraveling the enigmas surrounding wormholes and their consequences for our comprehension of the cosmos will need sustained multidisciplinary cooperation and technological breakthroughs.

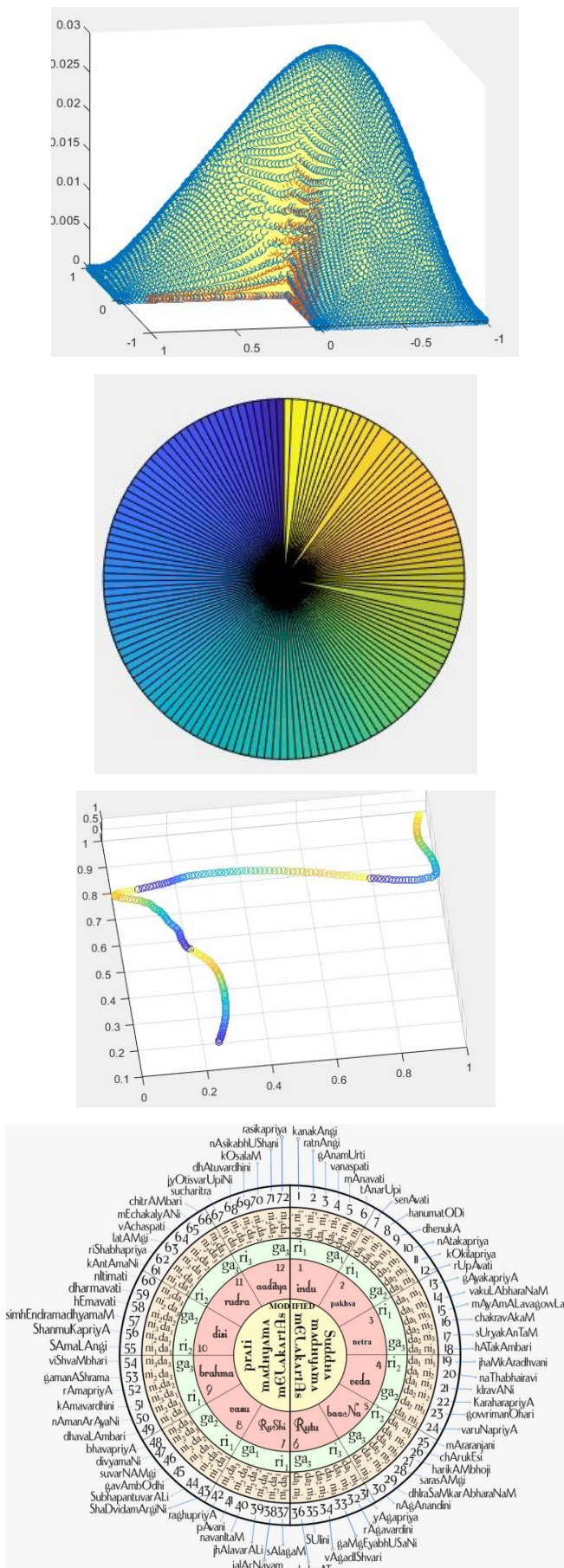


Fig 3. Matlab icon (Red Double Bounce =0.833 Blue Volume scattering;), volume scattering pie (Bernouli Lemniscate), Multicolor worm, Indian Melekat Raga

4. Conclusion

To sum up, wormhole research is an interesting and diverse field of study that goes outside the purview of conventional science. Researchers from a variety of fields have set out to solve the riddles of these cosmic tunnels, tackling topics ranging from the complex mathematics of general relativity to the theoretical domains of exotic matter and interstellar travel. Even though wormholes are still theoretical concepts, research into them provides important new understandings of spacetime, gravity, and the fundamental principles regulating the cosmos. Scientists work to unravel the mysteries of these mysterious formations and comprehend their possible cosmic ramifications through theoretical study, numerical simulations, and astrophysical observations. Wormholes also have a fascination that goes beyond science fiction to the imagination of storytellers and science fiction readers. Ideas such as time travel and trajectories across space pique our interest and encourage reflection on the vast possibilities that await us beyond the cosmic horizon. Every new finding and theoretical advance in our understanding of wormholes puts us one step closer to solving the universe's riddles. Even though it's still unclear if wormholes can be traversed, the exploring process itself is a monument to humanity's never-ending curiosity and spirit of exploration. As the ramifications and complexity of wormholes are explored further, it becomes clear that their study is more than just an academic pursuit—rather, it is an exploration of the fundamental structure of reality. Wormholes are fascinating because they have the capacity to completely alter our conception of spacetime and gravity while providing fascinating windows into universes where the rules of physics could function in ways that are currently incomprehensible. Wormholes are used in theoretical physics to test the boundaries of our theoretical frameworks and mathematical models. While exploring exotic matter stretches the frontiers of our understanding of basic particles and their characteristics, researchers can better understand the geometric details of these cosmic tunnels by diving into the complex mathematics of general relativity. In particular, the search for traversable wormholes pushes us to consider the elusiveness of negative energy density and its consequences for the stability of these theoretical structures. Beyond conjecture, observational astronomy and astrophysics are also impacted by the study of wormholes. Astronomers look for oblique evidence of wormhole existence through processes like gravitational lensing and the actions of celestial objects like black holes and neutron stars, even if direct detection of wormholes is still difficult. These discoveries reveal light on the larger astrophysical environment in which these mysterious structures may exist and offer insightful information about the cosmic circumstances under which wormholes could emerge and endure. Wormholes are fascinating, but their appeal goes far beyond the realm of scholarly study; millions of people are inspired by them in popular culture. Wormholes have come to represent cosmic inquiry and existential curiosity in literature, cinema, and other forms of art, encouraging reflection on humanity's role in the wide cosmos. Once confined to science fiction, ideas like interplanetary travel and time dilation are now seriously discussed by scientists and enthusiasts alike, obfuscating the distinction between speculative fiction and scientific research. The significance of wormholes serves as a reminder of the close connections between human creativity, philosophical investigation, and scientific discovery. These fictitious constructions act as a

cosmic keyhole through which we may view not just the secrets of the universe but also the boundless possibilities of human inquiry and inventiveness. The study of wormholes arouses amazement, curiosity, and the never-ending search for knowledge in the infinite cosmos, regardless of whether they turn out to be doors to far-off galaxies or simply mathematical mysteries. Maybe structure from motion (Green tensor stitching) and Galerkin's 'time-like' parameters lighting paves the way. The step function or Dirichlet integral for Magnetic inference from wormhole (Ashmit 3 algorithm) The Dirichlet integral or sigmoid function (smoothed stepfunction) RaySAR software is helpful.

Acknowledgement

Authors are grateful to Prof Amitabha Bhattacharya, Dr. Tapan Misra and Dr V Bali from IIT Kharagpur, Sisir Radar and IIT Madras. The theory of Everything reminds Dr. Stephen Hawking's.

References

1. Wormhole travel as envisioned by Les Bossinas for NASA, c. 1998
2. Visser, Matt (1997). "Traversable wormholes: the Roman ring". *Physical Review D*. 55 (8): 5212–5214. arXiv:gr-qc/9702043. bibcode:1997PhRvD..55.5212V. doi:10.1103/PhysRevD.55.5212. S2CID 2869291.
3. Deutsch, David (1991). "Quantum Mechanics Near Closed Timelike Lines". *Physical Review D*. 44 (10): 3197–3217. Bibcode:1991PhRvD..44.3197D. doi:10.1103/PhysRevD.44.3197. PMID 10013776.
4. Brun; et al. (2009). "Localized Closed Timelike Curves Can Perfectly Distinguish Quantum States". *Physical Review Letters*. 102 (21): 210402. arXiv:0811.1209. Bibcode:2009PhRvL.102u0402B. doi:10.1103/PhysRevLett.102.210402. PMID 19519086. S2CID 35370109
5. https://www.researchgate.net/profile/Stefan_Auer/contributions